MACHINE DESIGN

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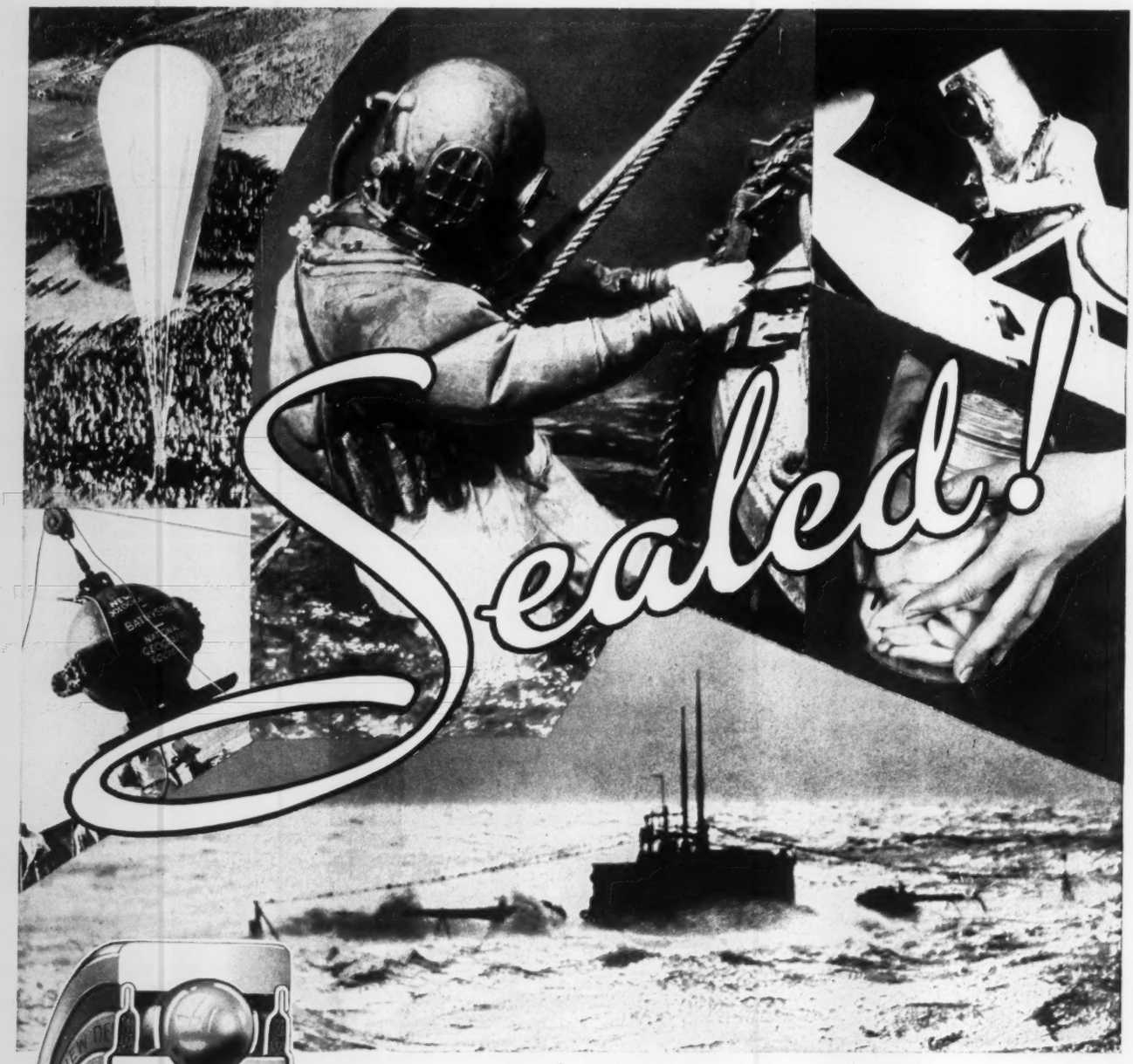

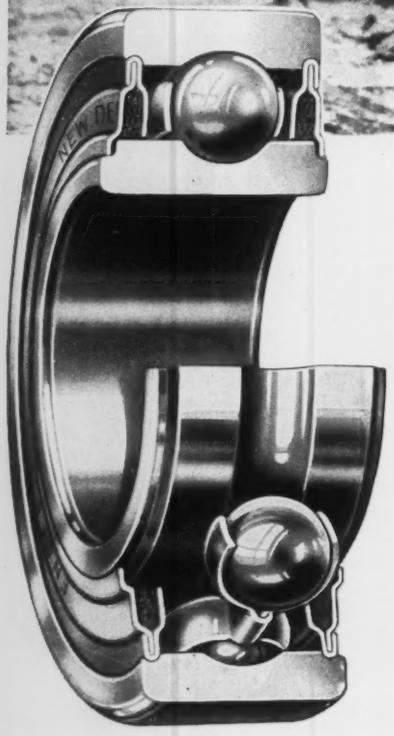

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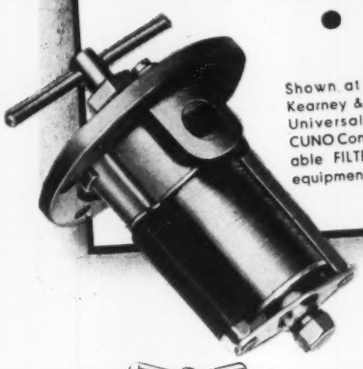

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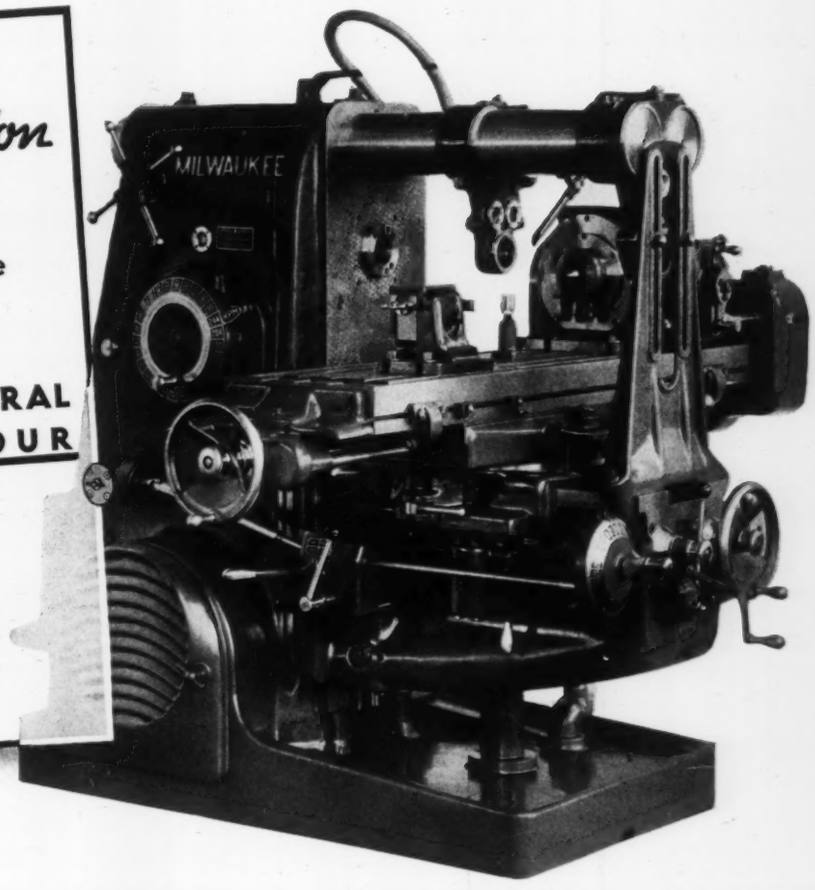

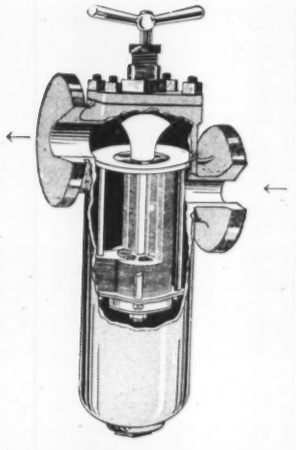

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PHOTOGRAPHY is becoming a real friend of the engineer and designer in helping him analyze problems that no amount of patient research could solve. The field of metallurgy has, of course, been dependent on microscopic photography for years, and in recent times movie cameras have been used for studies of high speed equipment to catch the instantaneous position of moving parts in machines. The latest adaptation of the camera to design was done by a power transmission belt manufacturer who always had a hankering to know what the gripping side of a belt under tension against a pulley looked like. He decided to observe the gripping quality of a stationary belt microscopically, so rigged up a glass pulley with a hole in one side through which he could place the microscopic lens of a Contax camera. A normal tension was applied to the belt and flashed pictures taken which showed conclusively that the pores in the leather, normally deep and close together, became shallower and farther apart when pressed against the pulley. The area or hummocks between the pores were forced against the pulley, thus producing the gripping action.

♦ ♦ ♦

We believe a new high has been set in wheels per vehicle with the announcement this month of a truck-trailer combination with 28 wheels. Its capacity is also believed to be the greatest of any trailer equipped with pneumatic tires, for it will haul a load of 30 tons. The mammoth trailer was designed to carry a steam shovel on highways where the load per tire must not exceed a certain limit. Arc welding was used extensively in the fabrication which was done by the Rogers Bros. Corp., Albion, Pa.

♦ ♦ ♦

Automobiles without gear shift levers are proving a boon in more ways than one. Recently thieves broke into a new Ford which was equipped with an automatic shifting device. When they noticed there was no clutch pedal or shift lever they abandoned the car thinking it was either a freak or that the absence of such parts would make it easy to identify!

♦ ♦ ♦

Automatic transmissions are not new, having been supplied on stock passenger cars in the past. This year, however, several more makers are equipping their vehicles with them with claims of driving simplicity, safety and more foot and leg room. The successful operation of 101 of the latest type transmissions on Chicago buses in the past few months has assured them a place in the motor-coach field at least. Gears are shifted by momentarily releasing the accelerator pedal, which causes the transmission to shift to the correct ratio for the speed of the vehicle. One-armed and one-legged individuals should find the device particularly attractive!

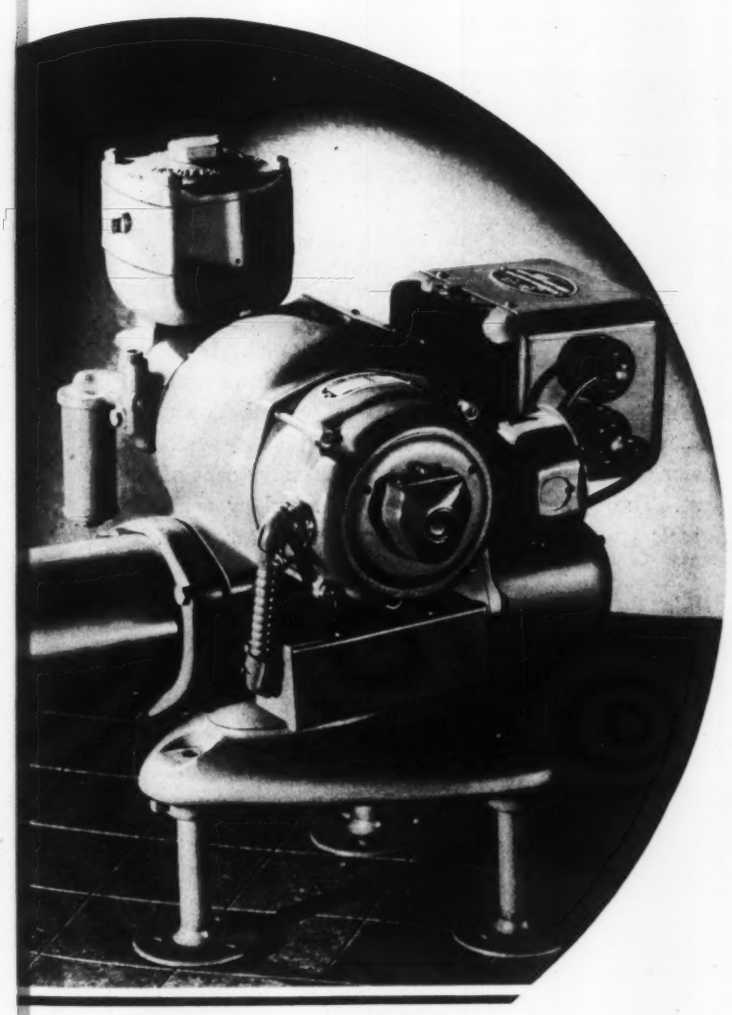
♦ ♦ ♦

Prosperity of the railroads is being reflected among machine tool makers. Since 1931 they have had to sit idly by and hope that a few dollars of the millions the government poured into the country's railroads would come their way. But operating costs and salaries ate up these funds and replacement parts or equipment were forgotten. This year, though, with most of the railroads running in the black in 1936, machine tool makers look for a substantial business. Already the railroads have given orders for 650,000 tons of rail and 4100 freight cars, and machine tools are the next in line for revamping and weeding out of the obsolete.

♦ ♦ ♦

The expression, "The good old days," is evidently just an hallucination judging from the words of Dr. W. D. Coolidge, director of the General Electric research laboratory. He reminds us that a few decades ago the unskilled workman earned on the average only 50 cents a day, the hours of labor were from sunrise to sunset and little beyond the bare necessities of life were obtainable by a laborer for his wage.

MACHINE DESIGN



g. 1—Built-in motor drives fan, atomizing device and metering system of burner

Engineering the Oil Burner

By Robert Witherall

Williams Oil-O-Matic Heating Corp.

THERE are four commonly-accepted laws set up as the requirements which must be met for the efficient burning of the heavier grades of oil used for domestic and commercial heating practice. These requirements seem to have an easy solution—just put a few parts and mechanisms together to satisfy the four basic laws and you have an oil burner. But modern mechanical concepts will not permit such a simple way out. Today's machine user demands unusual competence in the machine. The machine must be compact, especially those oil burners operating in a home, where they must also be trouble free. All in all, the design of an oil burner has progressed to a peak of design efficiency, precluding the possibility of a simple amalgamation of parts answering the demands placed on the machine.

The four fundamental laws are that the fuel must be atomized; a minimum quantity of air for supporting efficient combustion must be positively supplied and brought intimately in contact with the atomized oil; the oil must be burned in suspension; and the oil must be burned in the presence of a refractory. While

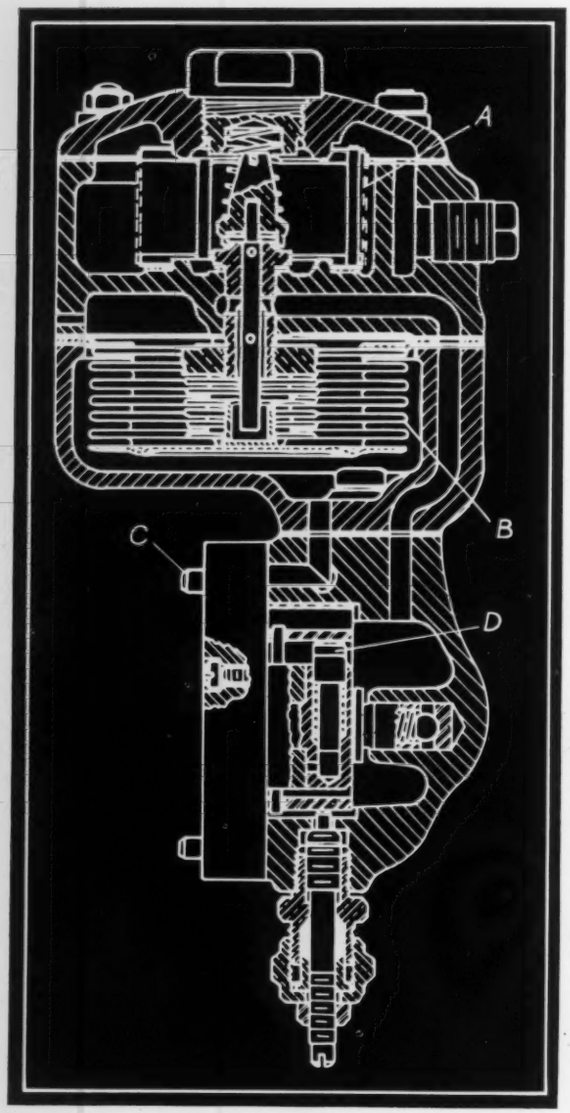


Fig. 2—Double bellows seal is incorporated in fuel system, one controlling the feed

this last law does not directly affect the machine designer, the other three enter very forcibly into his thinking. Further, engineers of Williams Oil-O-Matic Heating Corp. have added other requirements involving simple yet thorough mechanical design. They have adopted the principle of low pressure atomization, a principle which reduces power requirements, stress and wear on the mechanical parts and, most important of all, noise and vibration of the burner, while at the same time giving a high degree of atomization with heavy grades of oil. Naturally this extra provision necessitated some interesting and unique design steps.

Considering these requirements, let us go through the design of the Oil-O-Matitc burner of *Fig.* 1 to see how progressive design can meet difficult specifications. Though the primary requirement in any oil burner is the introduction of oil to the machine, this creates a real problem. Dirt and other foreign matter must be kept from interfering in any way with the operation of the unit. Provision must be made so that when the burner stops the oil valve closes automatically so that there is no leakage through the burner during the "off" period.

Fig. 2 shows the inlet valve assembly as used on the machine under discussion. Oil is brought to this valve assembly by a suction pump. Before any of the oil reaches the valve it must pass through the screen as shown at *A*. This 60-mesh copper alloy screen will stop practically all of the foreign matter from entering the machine. An auxiliary filter such as shown at the left of *Fig.* 1 can be used if especially bad fuel conditions exist. What little foreign matter does pass by the screen introduces a new problem and a competent solution. The metering device has a soft seat made of synthetic rubber known as Thiokol which resists the deteriorating effect of oil. Unavoidable minute grit or dirt is ground into this seat without harming the valve and without influencing the action in any way.

Two Bellows Are Utilized

To satisfy the second requirement of this valve, that it shut off automatically when the burner is stopped, an ingenious arrangement of bellows is used. As shown in *Fig.* 2 at *B* and also in *Fig.* 2, two bellows made of a copper alloy are employed. One of these bellows, the smaller one, provides a completely flexible seal, the efficiency of which does not vary with movement of the valve. The other bellows forms a secondary seal and controls valve movement. This control is governed by

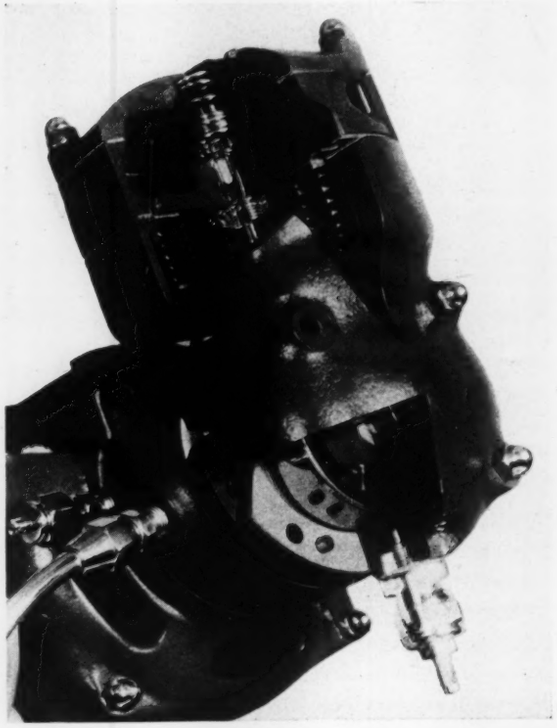


Fig. 3—Cutaway view shows fuel valve, above, and metering system, below

the pressure, developed in the atomizing system. A port at *C, Fig.* 2, is open to the atomizing system.

When the burner operates, pressure generated in the atomizing system backs up through this port to keep the valve open. When the pressure stops, the valve closes automatically through the action of the spring at the top. The small quantity of oil in the pump is sufficient to create the initial pressure necessary to begin operation after the burner has been stopped. Thus the oil and air under low pressure start the action which permits the entrance of more oil to the atomizing system. The body of this valve, as are all other major parts, is an electric furnace casting.

The inlet valve can, of course, be set to regulate the flow of oil, but this does not solve the problem of sending the correct amount of oil to the nozzle at all times. Fuel oils vary greatly in specifications. Two oils may have the same specific gravity but no other characteristics the same, or their specific gravities might vary widely and their specifications otherwise might be closely parallel. No two deliveries of oil to the storage tank are identical, as fuel oil being low-priced is not highly refined.

To overcome this difficulty the burner incorporates a metering device which delivers the same amount of oil per stroke regardless of slight variations in the specifications of the oil. This metering device can be seen in cross section in the lower half of *Fig.* 2 and in perspective in *Fig.* 3. Oil passes through ports by gravity to the inlet opening of the device. This device includes an eccentrically mounted rotor with lapped surfaces, the eccentric rotor operating a metering piston. In the position shown in *Fig.* 2, a definite metered quantity of oil is drawn from the sump into the cylinder. As the rotor turns the piston, *D,* is forced in by the eccentricity and the oil is pumped through discharge ports into the atomizing section of the burner. Excess oil is returned to the tank through a by-pass.

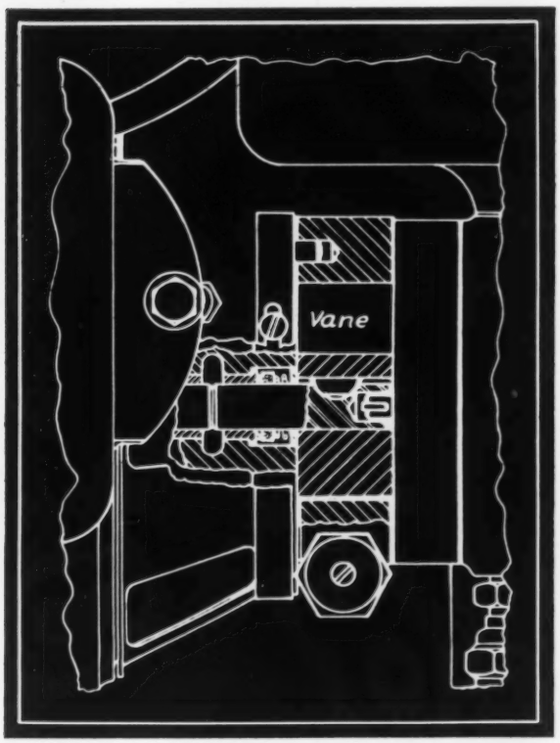


Fig. 4—Atomizing device operates on eccentric rotor and vane principle

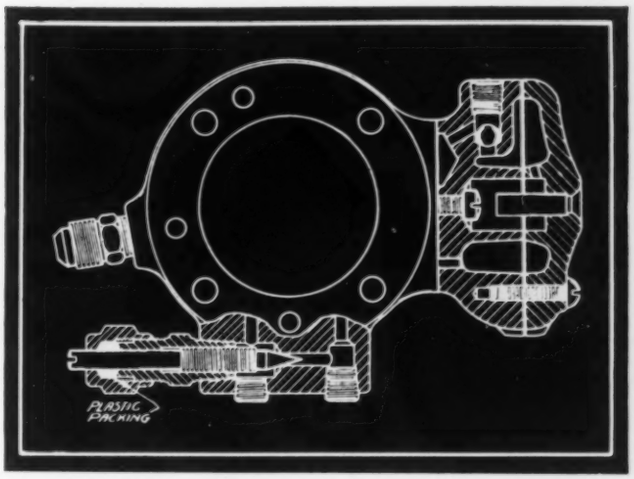


Fig. 5—Essential quietness is effected by use of this air intake muffler

The tip of the piston which contacts the surface and is exposed to the most wear is made of Bakelite, the use of which also reduces wear on the ring. Correct operation of the rotor is assured by the spring tension at the side, while the eccentricity may be adjusted by the screw shown at the bottom of *Fig.* 2.

Calibrated Nozzle Is Unnecessary

This principle of metering the amount of oil introduced to the burner does more than overcome the differences found in the oils. It also eliminates the necessity for a calibrated nozzle, a difficult device to maintain, permits the use of larger orifices which are not so prone to clogging, and the metering is done at low pressure, thus insuring accuracy unaffected by the possible variances in pressure.

The motor for the unit, shown in the foreground in *Fig.* 1, is of the capacitor start, standard frequency, induction type. Built as an integral part of the machine, this motor is fastened to the case of a blower for air supply. A single shaft drives all moving parts. At the rear of *Fig.* 1 can be seen the inlet valve assembly beneath which is the metering device. Between the metering device and the fan is an atomizing cylinder which takes the oil on through the sequence started in the foregoing.

As noted in the introduction of this article, one of the principles of combustion is that the oil must be atomized, or broken up, to enable efficient burning. The atomizing pump performs the function of breaking up the oil by throwing it into a stream of air which combines with it in definite proportion to suspend the

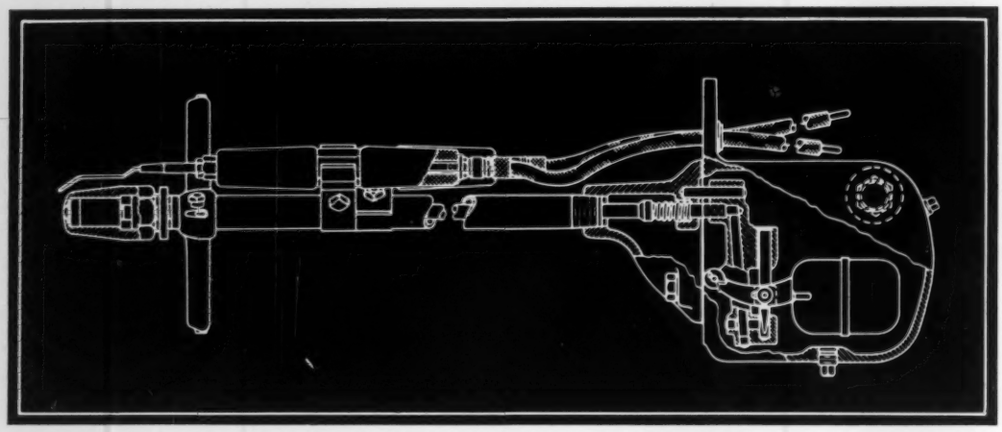


Fig. 6—Atomized oil settles out in diffuser chamber, is fed under pressure to burner nozzle, and again is atomized in air stream for proper combustion

oil particles. The atomizing cylinder, shown in *Fig.* 4, is of the vane type. Air in a definite proportion is sucked in through a muffler while oil, again in definite proportion, is supplied by the metering device. The rotor of the atomizing cylinder is eccentrically located with respect to the housing, and centrifugal force throws out the Bakelite vanes. Suction draws in the oil and the action of the vanes, forced in by the eccentric ring, pumps it out. In this way oil and air are mixed under low pressure. The pressure of this mixing or mingling of oil and air, as before noted, is communicated to the oil inlet valve to control incoming oil; and a by-pass valve controls the pressure in the atomizing cylinder to predetermined levels. Atomization at the burner nozzle is obtained at a pressure of approximately two pounds, this low pressure permitting the meeting of the ideal specifications and their advantages as brought out in the foregoing.

Obviates Noise from Suction

The air intake muffler used with the atomizing system is shown in *Fig.* 5. It is employed in order to obtain quiet operation, as otherwise the suction of the atomizing cylinder would create disturbing noise. The air is drawn in through an opening in the center of the cover, passes through several passages and then to the atomizing cylinder. A flexible diaphragm between the cover and the housing muffles the air as it passes through. This arrangement affords quiet air passage but at the same time the openings are large enough to prevent frequent clogging. The screw valve which can be seen in *Fig.* 5 controls the amount of air supplied.

At this point it might be thought that the oil, now mixed with air, is ready for firing. This is not the case, however. The mixing of oil and air is merely an essential step for breaking up the oil and establishing the correct proportions. The resulting mixture is not directly fired. Instead, it is introduced to a diffuser chamber where the oil is allowed to settle out. Then the oil and air are transported separately to the nozzle and again mixed and atomized. This second mixing permits an even flow of combustible material to the nozzle, eliminates the vibration accompanying the high pressure forcing of liquid through the tube, and gives better ignition.

Returning to the diffuser of *Fig.* 6, the atomized oil under low pressure is forced to the chamber shown. The oil settles out through gravity until the liquid level raises the float ball and opens the valve. The opening of this valve permits the oil under pressure to be forced out through the smaller tube. Air, also under pressure, passes out between this smaller tube and the larger one. Arranged as it is, this valve serves to meter the oil flow again and give one further check to be certain that the correct quantity of oil is delivered to the nozzle.

Even after the oil and air have passed into their respective tubes, the engineer's job is not done. It now becomes necessary to atomize the oil and project it into a steam for combustion. This atomization is performed by a mixing chamber at the extreme end of the tubes, *Fig.* 6. Angular slots at the opening of the chamber whirl the oil so that it again combines with the air in the predetermined proportions to form a fine-spray stream. The resistance of the angular slots is a necessary part of the process and aids in creating the velocity of the expelled oil. As the orifice is set and must be maintained at all times, the outlet valve is manufactured from a copper alloy which is practically self-seating. A spring on the oil tube, right end in *Fig.* 6, maintains the proper tension at the seat.

The primary function of the air taken in by the atomizing pump is to effect atomization. The mair. air supply for supporting combustion is drawn in by the fan, the quantity being governed by an air volume control, and the air being discharged through the draft pipe, *Fig.* 1, then passes over an air deflector cone in such a manner as to mix intimately with the discharged atomized oil.

Pumps, motors, valves, controls, bellows and many other parts are competently combined in this unit to provide efficient operation of one comparatively small machine, an oil burner. Such careful engineering again illustrates the importance of design competence on every machine, regardless of its size or the function it is called on to perform.

SCANNING THE FIELD FOR IDEAS

MACHINERY plays a constantly increasing part in the processing of foods. An example is in the sanitary drying of the great quantities of whole milk, skimmed milk and buttermilk used in flaked and powdered form in the wholesale manufacture of ice cream, baked goods, candies, etc.

The manner in which this is accomplished is made clear by *Fig.* 1, showing a double-drum milk dryer developed by the Buffalo Foundry & Machine Co. The machine has two closely spaced steam-heated drums which revolve toward each other. At their two ends are stainless steel splash plates fitted closely to retain the milk which is fed from a perforated pipe into the space between the drums. Through action of heat the surfaces of the drums become coated with a film of milk which dries quickly as the drums turn.

On opposite sides of the drums are adjustable knife mechanisms somewhat resembling wood planes which shave the dried film of milk off the surface. The shavings fall down into troughs in which are Link-Belt ribbon conveyors. These carry the dried material to a bucket elevating mechanism which in turn delivers it to a flaker where it is reduced to the desired degree of fineness.

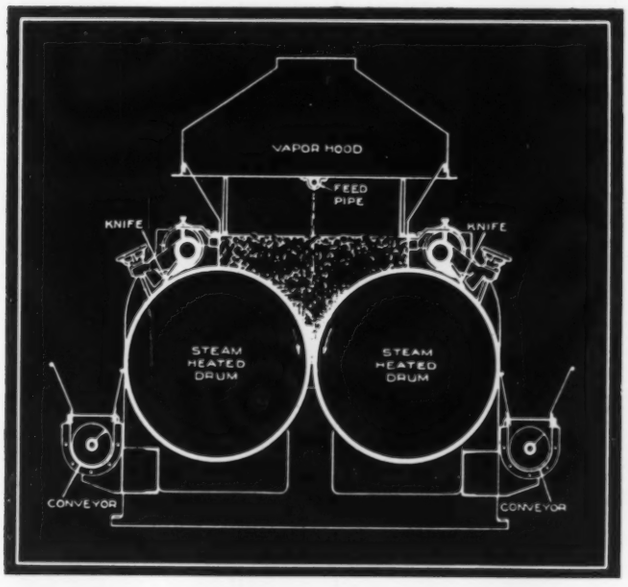


Fig. 1—Revolving steam-heated drums gather film of dried milk which is "planed off" by adjustable knives

The drums, 42 inches long and 100 inches in diameter, are of close-grained cast iron precision ground.

Goggles Control Grinder

ENFORCEMENT of the rule that no grinding shall be done by a workman whose eyes are unprotected has been made automatic in the mechanical department of C. F. Burgess Laboratories Inc. This is through an application of one of the Micro Switches manufactured by that organization. The left-hand view in *Fig.* 2 shows that grinder at rest while the right-hand close-up shows it running.

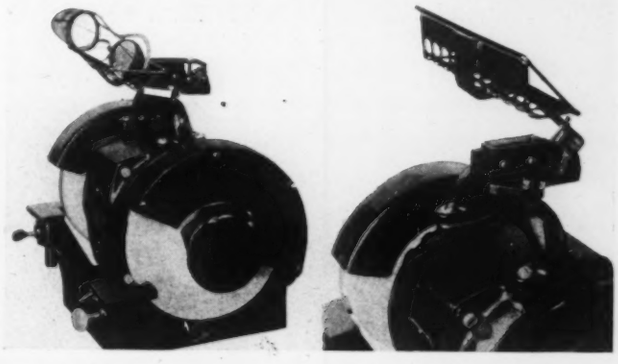


Fig. 2—Grinder is inoperative until operator puts on goggles, their weight holding micro switch open

The switch is mounted on a yoke at the top of the grinder as a part of the unit consisting of a tray on a light spring hinge. When the goggles lie in this tray their weight is sufficient to keep it down and to depress the operating button at the rear of the Bakelite housing of the switch so as to break the circuit of the current through the driving motor of the grinder. As soon as the workman picks up the goggles to put

them on, the tray flies up, releasing the switch button and starting the grinder.

Although the switch operates by only 4/1000 ounce-inches of energy, it safely carries the full line load of the half-horsepower grinder motor without requiring intermediate relays.

Weighing Is Automatic

AN INGENIOUS combination of electrical and mechanical actions is embodied in a line of batch weighing machines designed by the Syntron Co. One of these is shown in *Fig.* 3, the weight hopper in this case being in position for filling. The control cabinet is open to show the control panel, switches, relays, etc. and other electrical apparatus.

The weighing hopper is mounted on an even balance scale and is fed from a main supply hopper through the medium of an electromagnetic pulsating feeder. The scale is equipped with two electrical controls. One cuts out the high speed feed through the pulsating feeder when approximately 80 per cent of the batch has been "weighed in." The other stops the subsequent "dribble feed" at the instant when the exact weight of material has been deposited in the weighing hopper. Then the machine dumps the weight hopper and—in the case of the full automatic type illustrated—resets itself and repeats the operation.

Two other arrangements can be provided. When arranged for manual dumping, the weight hopper is discharged by hand after batch feeding has been completed. With electrical timing, control is from a clock, the weight hopper being dumped automatically at regular intervals such as every quarter-minute.

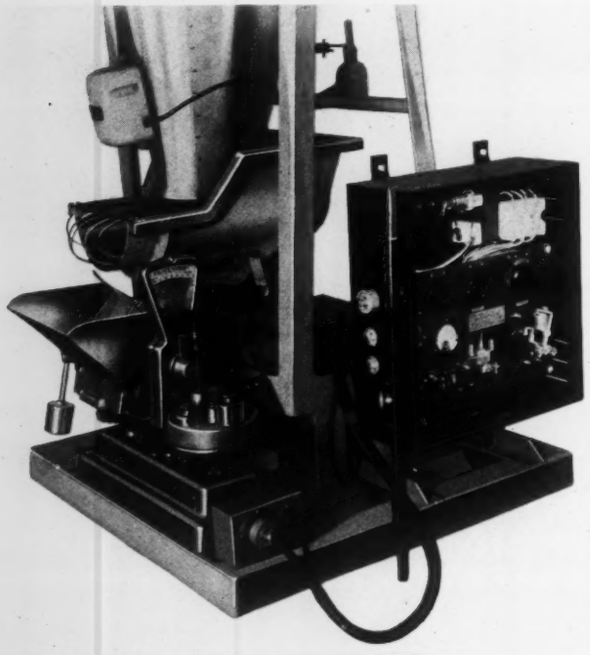


Fig. 3—Electric feed and control in conjunction with an even-balance scale insure exact batch weighing

The casing which can be seen fastened to the left side of the funnel-shaped supply hopper, houses a noiseless electromagnetic vibrator which keeps the contents of this hopper from clogging up and arching over, thereby insuring free flow into the pulsating feeder below.

The pulsating feeder consists of a trough suspended on springs and it is actually reciprocated (not merely vibrated) by powerful electromagnets having rhythmical impulses but differential reciprocation. "Slow motion" analysis of this cycle shows that by magnetic action the trough first is yanked out from under its load, which falls perpendicularly for a short distance, whereupon the trough is returned by spring action and forward to its original position. Rapid repetition of this cycle results in a forward flowing movement of the material.

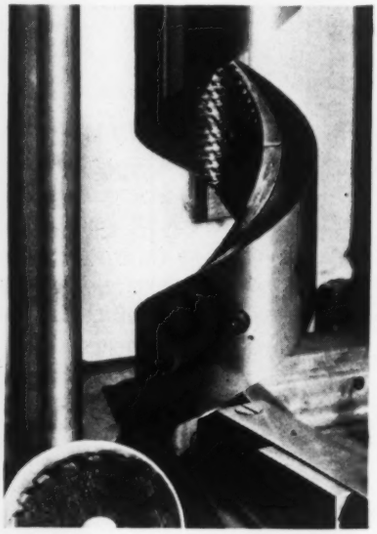


Fig. 4—Adaptation of spiral makes possible external broaching with an internal broach, teeth being cut on sector which have angle required for meshing with worm

Broach Cuts Spiral Teeth

SINCE the conception of the Archimedian screw for raising water, numerous ingenious mechanical applications have been made of the principle of the spiral. A recent example is given in *Fig.* 4, which shows a spiral broach with teeth on the inside which cut ten external gear teeth of spiral shape on wormwheel sectors of operating arms of steel casement windows. This is a development of the Colonial Broach Co.

This peculiarly shaped tool is given a double motion, reciprocating and turning, the result being that it follows the path of its own spiral-transmitting that path to the teeth that it cuts on the sectors. The teeth, of course, have the same lead as the broach itself. It will be noted that the broach is of sectional design, the spiral guide or body being one piece of tough metal, while the cutting members consist of removable hard-

ened spiral plates fastened to the body by hollowhead screws. The toothed sector of one of the casement arms is shown in the insert at the lower left-hand corner of the illustration.

Hammer Tests Finishes

ORGANIC finishes are now made so hard and adhere so firmly that a nail coated with them actually can be driven into hard wood without appreciably damaging the coating. To carry out tests for adherence and deformability on these hard, tough finishes, Bell

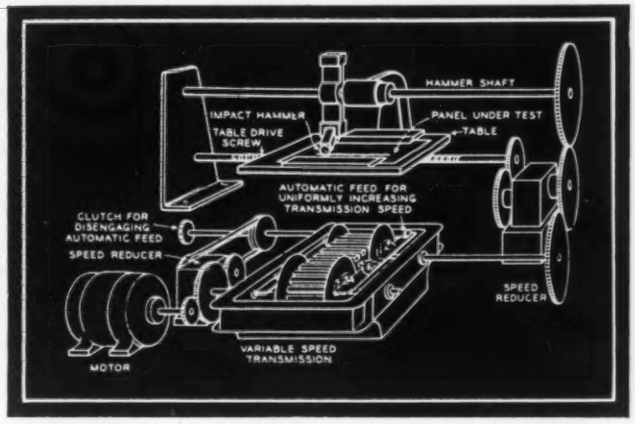


Fig. 5—Diagram showing power train of progressive hammering machine for testing finishing materials

Telephone Laboratories has recently developed the progressive hammering machine of which *Fig.* 5 is a diagrammatic sketch.

The test panel is clamped to a table on a carriage moved laterally by a lead screw. Over this table is a revolving member carrying a loosely pivoted hammer with a spherical head. This hits the test panel a glancing blow at each revolution, at the same time brushing aside any loosened particles of finish.

Hammer mechanism and carriage are driven in synchronism by a motor which advances the carriage 0.020-inch for each revolution of the hammer, thus presenting a fresh but closely adjoining area to each blow. Intensity of hammer blows can be gradually increased by speeding up hammer rotation by means of a variable diameter pulley and V-belt speed changer. Variation is accomplished automatically by belting the pulley control screw of the speed changer to the primary reduction gear driven by the motor.

When blows of constant intensity are desired, the control screw of the variable speed mechanism is turned to produce the desired hammer speed. Its clutch is then disengaged—whereupon speed of rotation remains constant as the test panel advances. Hammer action can be observed closely through a shield of double safety glass.

When blows of constant intensity are being delivered, the specimen is moved back and forth under the hammer until the finish is destroyed—the number of repetitions being taken as the gage of impact resistance. When increasing intensity is employed the test is continued through one complete cycle of hammer blows, in which case the intensity required for destruction by a single blow is taken as the measure of resistance. Revolutions per minute of the hammer at point of failure is known from prior determination of its speed at corresponding lateral position of the carriage.

Eases Control of Shovels

CENTRALIZATION of control of power shovels, draglines and cranes has been achieved by Link-belt Co. through application of hydraulic means. A heavy crawler shovel fitted with this new control system is shown in operation in *Fig.* 6.

It will be noted that instead of standing behind the usual array of exposed long-throw levers, the operator in this case remains seated in a comfortable truck-type seat in a cab located at the strategic operating position. In front of him is a small control "desk" on which is a row of short-throw levers. These levers, which can be moved by a mere flip of the wrist, start and stop the hydraulic motor units which—through power drawn from the machine itself—do the heavy work of clutching, unclutching and braking the numerous operating details of the machine, giving rapid and smooth acceleration and deceleration of its various functions. Foot pedals likewise within easy reach of the seated operator work in the same manner.

This control system is said to reduce operating fatigue and at the same time to give speedier action.

Fig. 6—Hydraulic control system for heavy power shovels reduces operating effort

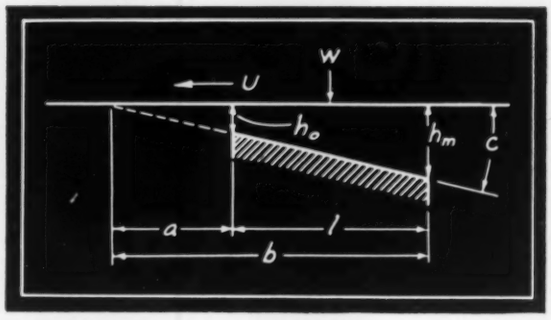


Fig. 1—Flat plate moving over stationary one provides basis for making bearing oil film calculations

Attaining the Maximum

By L. J. Bradford
and
R. S. Wetmiller

EVERY bearing designer and lubricant maker would like to develop a bearing and lubricant combination that will always keep the two rubbing surfaces completely separated, no matter how heavy the imposed load may be. Theoretically this is entirely possible, for the hydrodynamic theory shows that while increasing loads cause decreasing clearances between the rubbing surfaces, actual contact will not occur until an infinite load is reached, provided the surfaces are mathematically smooth. Actually, rubbing surfaces are far from being that smooth. The high ridges on each surface cut through the thin film resulting from high pressures and contact each other. This causes heating, wear and most of the other ills a bearing is heir to. Let us examine the expression for the carrying capacity of a flat plate and see what factors enter into it and what can be done with them, with a view to attaining more closely our ideal.

Equation Is Derived

Fig. 1 shows a stationary flat plate carrying a load placed on a moving plate and separated from it by a space which converges in the direction of motion. This space is filled with a fluid, having a viscosity, μ, which submerges the two plates. Both plates are infinitely long in a direction perpendicular to the paper, and there is, therefore, no end leakage. For these conditions Osborne Reynolds gives the carrying capacity per inch of bearing width perpendicular to the paper as:

$$W = -\frac{6\mu U}{c2}\left(\log_e \frac{b}{a} + 2\frac{(a-b)}{(a+b)}\right) \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Reynolds also shows that for maximum capacity

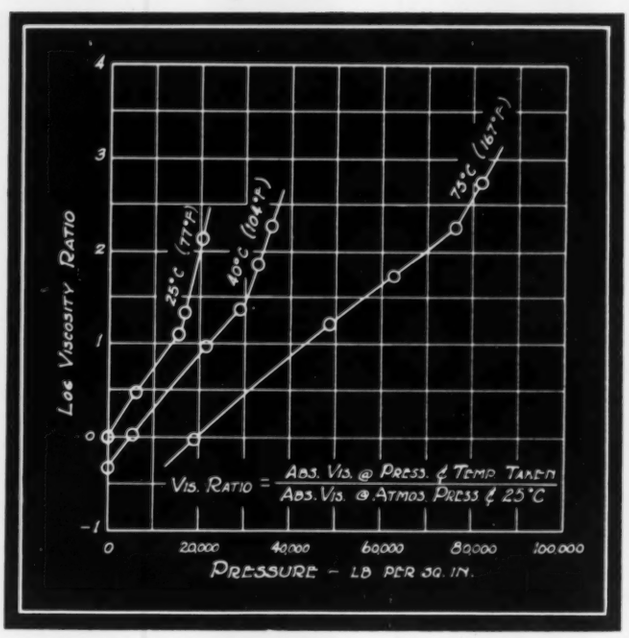


Fig. 2—With increase in bearing pressure oil viscosity is raised considerably

$h_m = 2.189\, h_0$ and for minimum friction $h_m = 2.533\, h_0$. If the viscosity, μ and rubbing velocity, U, are held constant it will be found that increasing the value of W causes a decrease in the values of h_m and h_0, the thickness of the film separating the rubbing surfaces. If the film thickness be held constant, then two other means are available for carrying load increases. They are:

1. Increased rubbing velocity.
2. Increased viscosity of the lubricant.

If either of these varies directly as the first power of the load, then we should have within our grasp the ideal we have been seeking.

As a general thing the speed of a journal is fixed by the demands of the machine and does not vary directly as the first power of the load. It may be dropped from

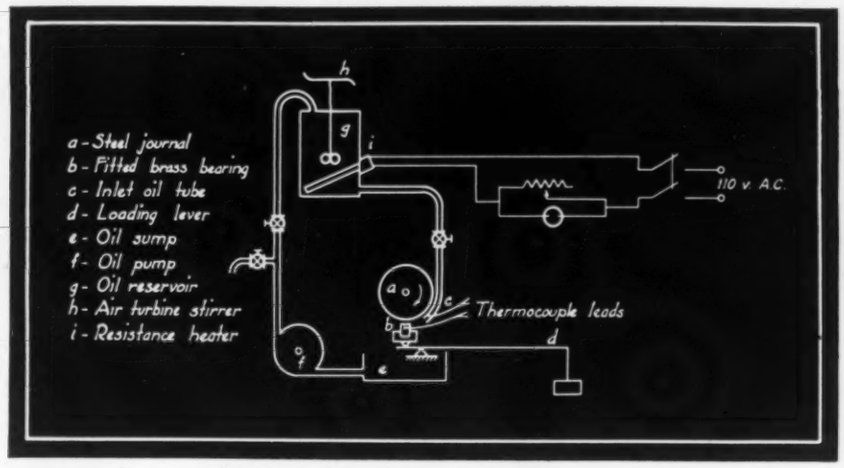

a - Steel journal
b - Fitted brass bearing
c - Inlet oil tube
d - Loading lever
e - Oil sump
f - Oil pump
g - Oil reservoir
h - Air turbine stirrer
i - Resistance heater
110 v. A.C.
Thermocouple leads

Fig. 3—Apparatus, diagrammatically shown, for applying pressure to bearing and determining bearing and oil temperatures

m in Bearing Performance

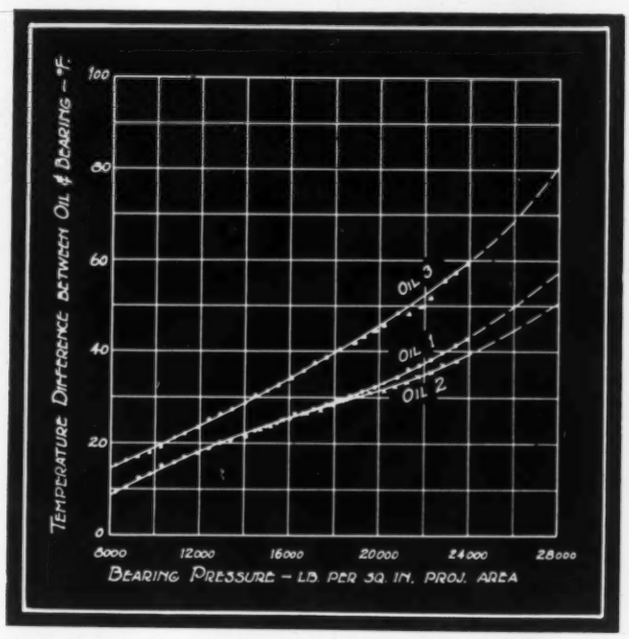


Fig. 4—Difference in oil and bearing temperatures increases with bearing pressure for three types of oil tested

consideration. This leaves the viscosity behavior under load to provide the extra carrying capacity.

Data on the variation with pressure of the viscosities of fluids are meager, but such as are available show that the viscosities of oils increase with pressure and that this increase is especially rapid in the high pressure region. *Fig.* 2 shows the variation of viscosity with pressure for a Pennsylvania oil obtained by Kleinschmidt. This phenomenon is just what is needed to give a high duty bearing the capacity required.

It will be noted, however, that in the low pressure region the rise of viscosity with pressure is slight. This means that when we load our bearing surfaces they will first move together reducing the thickness of the oil film and thus securing the additional capacity required by the increasing load. Then will come a time when load and viscosity will increase at the same rate and no change will occur in the film thickness. After that the viscosity will increase more rapidly than the load, and the rubbing surfaces will actually move apart giving increased film thickness. All this assumes that the temperature remains unchanged.

EFFECTS of temperature and pressure on a bearing oil film are comprehensively analyzed in this article. The authors have conducted experiments in oil viscosities at Pennsylvania State college. Mr. Bradford is professor of machine design and Mr. Wetmiller is research assistant in mechanical engineering

Unfortunately the work of friction increases with the load and this results in a steady increase in the running temperature of the bearing. This in turn causes a decrease in the viscosity of the lubricant and a reduction in the thickness of the film separating the two rubbing surfaces.

Three Factors Determine Performance

From the foregoing discussion it will be seen that the attainment of a bearing which will carry extreme loads without permitting metallic contact of the rubbing surfaces rests on three factors:

1. Rate of increase of viscosity with pressure.
2. Rate of decrease of viscosity with temperature.
3. Smoothness of journal and bearing sufficient to permit the initial close approach which occurs before the effect of pressure on viscosity becomes dominant.

With a view to investigating these phenomena, an experimental bearing and journal have been made at Pennsylvania State college. It consists of a fitted brass partial bearing 0.135 inch by 0.271 inch with the long

dimension placed parallel to the axis of the journal. The bearing is mounted in a holder which rests on a knife edge on a lever through which the load is applied. This knife edge permits the bearing to tilt so that the necessary wedge-shaped film convergent in the direction of motion can be formed. A thermocouple is embedded in this bearing with its junction about 1/32 inch below the rubbing surface to permit determination of the temperature of the bearing. The journal is made from the outer race of a tapered roller bearing 1⅞ inches in diameter. It was honed smooth with a razor hone flooded with gasoline and then polished with emery polishing paper of several degrees of fineness, *No.* 0000 being used last. The brass bearing was carefully worn in by running against the journal until a perfect fit was secured. Such brass as was plated on the journal during the wearing-in process was removed with emery polishing paper.

The machine was operated at 465 RPM with a flood of oil supplied at a constant temperature of 130 degrees Fahr. Loads were applied in increments of about 500 pounds per square inch projected area, and for each increment of load the temperature of the bearing was noted by means of the thermocouple embedded in it. *Fig.* 3 shows the arrangement of the apparatus diagrammatically.

No Brass Deposited on Journal

It was found that when all conditions were favorable, loads of 24,000 pounds per square inch of projected area could be carried indefinitely without any deposition of brass upon the journal. In fact, on one occasion a load of around 30,000 pounds per square inch was so carried. *Fig.* 4 shows typical result curves in which the difference in temperature between that registered by the thermocouple in the bearing and that of the oil supply is plotted against bearing pressure in pounds per square inch of projected area of bearing.

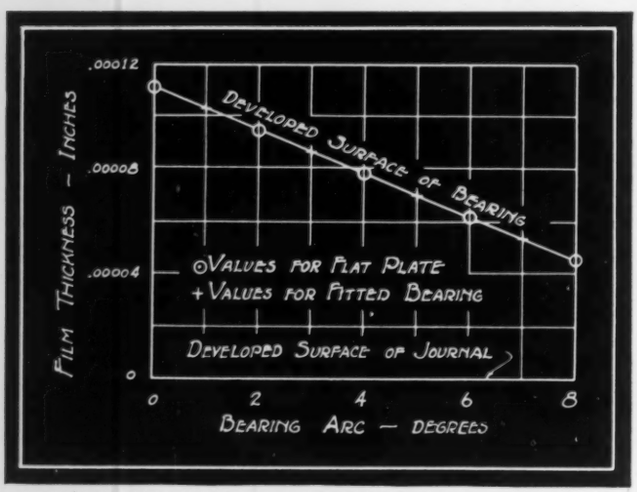


Fig. 5—Shape of oil film for a bearing and an inclined flat plate is practically the same

The fact that no brass was deposited on the journal during several hundred hours of operation leads the authors to believe that fluid film lubrication existed and that this was made possible by the increase in the viscosity of the lubricant caused by the exceedingly high pressure to which it was subjected in passing through the space between the journal and bearing.

Bearing Considered as Flat Plate

In order to obtain an approximate check on this surmise the bearing was assumed to be a flat plate as shown in *Fig.* 1. This assumption is not greatly in error as the arc subtended by the bearing is only 8 degrees. *Fig.* 5 shows that the shape of the oil film does not differ materially from that formed by an inclined flat plate. Loads were then taken corresponding to the bearing pressures imposed during the tests and, using equation (1) corrected for end leakage, the corresponding minimum film thicknesses were calculated for a Pennsylvania oil (*No.* 1) having an absolute viscosity of 39.5 centipoises at 130 degrees Fahr., a viscosity index of 103, and a journal speed of 465 RPM. The variation of viscosity with pressure was determined from a curve prepared by the Kingsbury Machine Works and made available to the authors through the kindness of H. A. S. Howarth. It is based on the work of Kleinschmidt and others.

Fig. 6 shows the variation of minimum film thickness under several conditions. Curve *A* shows the variation when the temperature is assumed to be constant at 167 degrees Fahr. Under this condition a minimum film thickness of .000024 inch is reached at a bearing pressure of 8000 pounds per square inch. After that the film thickness increases with increasing bearing pressure. Obviously, under these conditions, if the rubbing surfaces were smooth enough to permit an approach of the journal to the bearing of .000024 inch without the high spots coming into contact, breakdown of the oil film would be impossible and the fluid film bearing of infinite capacity would be a reality.

Curves Show Film Thickness

Curve *B* shows the variation of the minimum film thickness when the film pressure is assumed atmospheric and only the rise in temperature due to the work of friction is taken into account. In plotting this curve the temperatures used were those actually found in tests on this oil (see *Fig.* 4). The film thickness decreases continuously as the load increases.

Curve *C* shows the variation of the minimum film thickness when the viscosity is corrected for both temperature and pressure. In this case the minimum thickness of the oil film reaches a minimum value of .000031 inch at a bearing pressure of 15,000 pounds per square inch, recovers slightly until a pressure of 22,000 pounds per square inch is reached, after which it drops rapidly.

It is interesting to note that in running-in the test bearing blocks real difficulty with seizure is first encountered at pressures around 15,000 pounds per square inch. Loading is mastered at this pressure and it is quite easy to reach 22,000 pounds per square inch, but ability to carry 24,000 pounds per square inch is secured only through the exercise of the greatest skill and patience, combined with not a little good fortune. This seems to lend confirmation to the calculations.

Fig. 7 shows the effect of viscosity index on film thickness. These curves were prepared for a Pennsylvania oil (*No.* 2) having an absolute viscosity of 38.5 centipoises at 130 degrees Fahr. and a viscosity index of 113, and for a mid-continent oil (*No.* 3) having an absolute viscosity of 41 centipoises at 130 degrees Fahr.

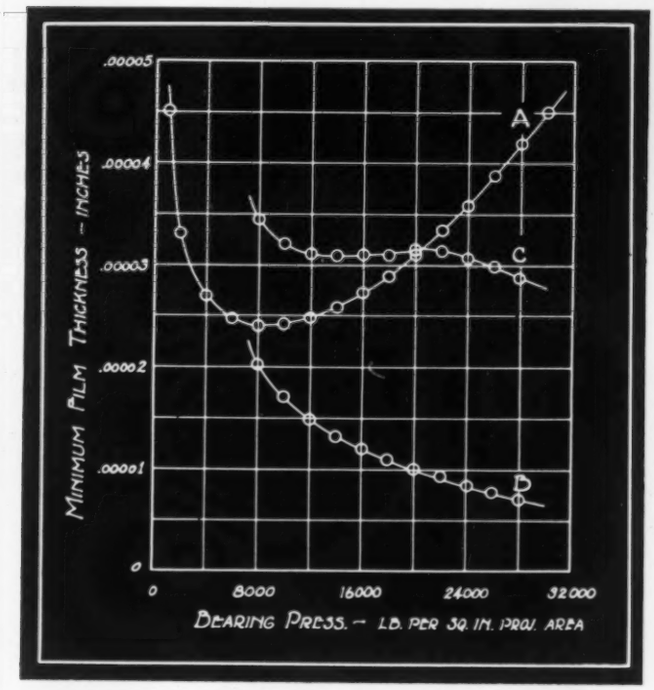


Fig. 6—Curves illustrating the effect on oil film thickness as bearing pressure is increased under three conditions

and a viscosity index of 79. For comparison, curve *C* of *Fig.* 6 is also plotted. As was the case for curve *B*, the temperatures used were taken from actual tests on these oils (see *Fig.* 4). In the case of oil *No.* 2 the curve shows a much more marked recovery of minimum film thickness after passing its first low point, a gain of about 7 per cent being shown over that for oil *No.* 1 at 22,000 pounds per square inch. This oil is certainly better suited for high pressure work than oil *No.* 1. In the case of oil *No.* 3, however, no recovery at all of minimum film thickness is realized after reaching its first low point, a loss of about 6 per cent being shown under that for oil *No.* 1 at 22,000 pounds per square inch. Obviously this oil is not as suitable to high pressure work as oils *Nos.* 1 and 2.

It should be emphasized here that the results shown

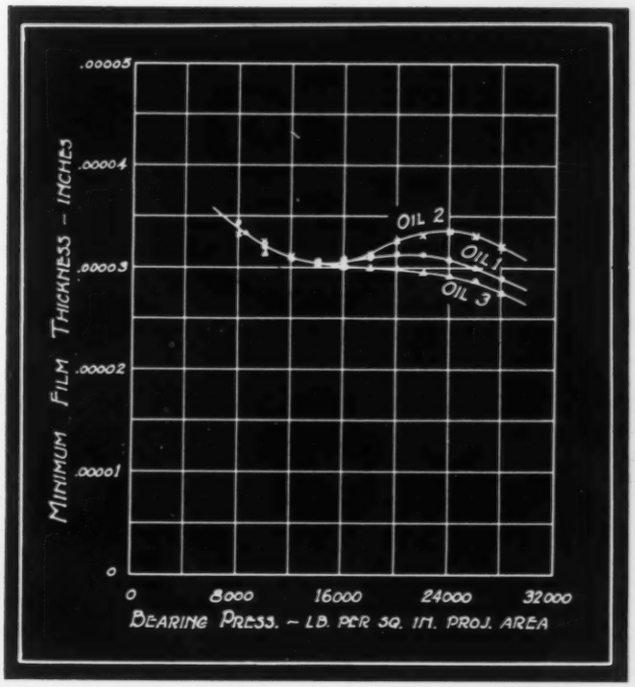


Fig. 7—Viscosity property of three oils effects appreciably the oil film thickness under increased bearing pressure

in *Figs.* 6 and 7 can be regarded as qualitative only, as no exact data are at hand either as to the viscosity-pressure relationship of the oils under consideration, or as to the viscosity index of these oils when subjected to pressures upwards of 20,000 pounds per square inch. There is a crying need for a thorough and extensive investigation into these phenomena.

Even when due allowance is made for the uncertainties mentioned, the results outlined carry significant messages to designers of bearings and to oil refiners who are striving to produce super capacity bearings.

To the former they say produce journals and bearings with as low ridges and striations as possible and devoid of ragged filaments of metal which may engage similar filaments of the opposing surface. To the latter they say produce an oil with a high viscosity index and also a high rate of viscosity increase with pressure.

Given these two factors in sufficient measure, the ideal bearing of the future will become the actual bearing of today.

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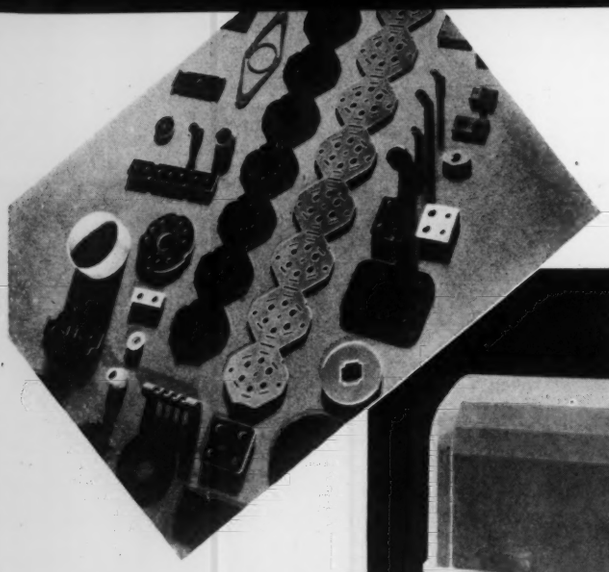


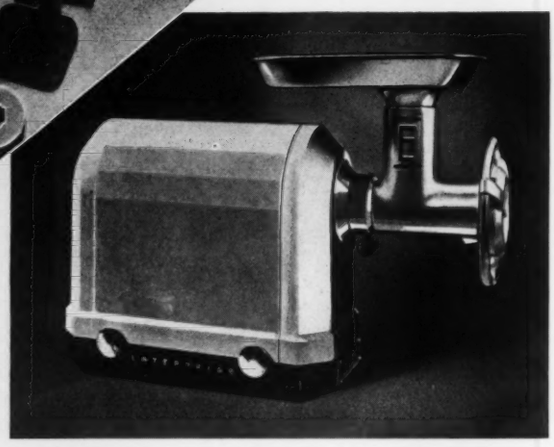


Fig. 1—Typical parts made from laminated plastics. Fig. 2—Right—Meat chopper has molded plastic case

Plastics Tid

By J. Delmonte

DEVELOPMENTS in plastics and synthetic resins have made available a large number of materials possessing qualities which are of distinct advantage to those engaged in the design of machinery. To the average engineer who first takes interest in plastics with the intention of applying them in his design, the large number of available products and materials is confusing. In the end, his choice may be decided not so much by engineering interpretation as by recommendation of someone who has tried a material with success or by the alertness of a sales engineer.

About ten years ago Bakelite and plastics were synonymous. Since that time, which marked the termination of Dr. Baekeland's original patents, the industry has grown to enormous proportions, and today there exist hundreds of tradenames for plastic products manufactured in the United States and Europe. Consequently, it is to the advantage of the machine designer from the consumer point of view to be informed of the various classifications of plastic materials. These classifications should logically serve as a starting point in the selection and application of the proper material. Following this, a discussion of those characteristics of plastics of interest to designers will be given in this article, with references to existing applications.

A plastic material is essentially a solid organic material of natural or synthetic origin. TABLE I groups the great majority of plastic products in accordance with their origin, listing the available forms in which the materials may be purchased. It should be mentioned that wide distinctions exist among the products listed under a single classification. These distinctions will be clarified on examining the various binders and fillers that are used with plastics, discussed later in the article.

There are two general classifications of plastics; thermoplastic and thermosetting. The former type is softened by heat. Groups I, IIC and IV fall in this classification. Thermosetting plastics undergo complete chemical and physical changes in their manufacture, becoming permanently infusible. Groups IIA, IIB, III and V comprise this class.

It is a natural question for one unfamiliar with the applications of plastics to ask what are the general characteristics of plastics which make them desirable materials to use in machinery. This is best answered by tabulating the major qualifications so that in the discussions which follow the reasons for indicating a particular material will be apparent.

The factors influencing the selection of plastics for machine design are:

a. Attractive appearance lends to sales appeal.
b. Saving in weight.
c. Simplicity in the design of the finished product, with the possible elimination of machining, finishing or assembling operations.
d. Superiority over present materials in wear resistance and durable finish.
e. Resistance to chemicals and corrosive atmospheres.
f. Economy of the design.
g. Superior electrical characteristics.
h. No other materials available.
i. Transparency.

The attractive appearance which plastics lend to

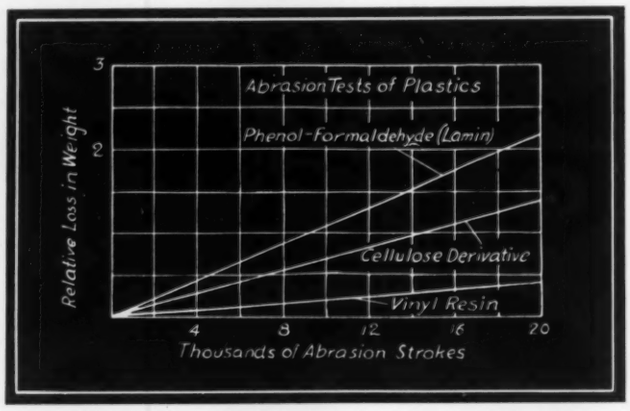


Fig. 3—Curves show comparative abrasion resistant qualities of different plastic materials

id Surges Swiftly Onward

equipment cannot be underestimated as a factor in strengthening the sales appeal. First impressions are lasting with the consumer, and a pleasing external appearance will do much to put the article over. While the engineer realizes that the true worth of a commercial machine lies in its performance, it will not find a market unless the discriminating average citizen finds the equipment pleasing to the eye. Consequently,

TABLE I

Classification of Plastics

Origin	Typical Forms	Typical Machine Applications	Typical Tradenames (United States)
I. Cellulose Derivatives			
a. Cellulose Nitrate	Sheets, tubes, rods	Decorative	Pyroxylin, Celluloid, Fiberloid, Nixonoid
b. Cellulose Acetate	Sheets, tubes, rods molding powders	Decorative, knobs, dials, handles	Acelloid, Celanese, Fibestos, Kodapak, Lumarith, Masuron, Plastecele, Tenite
II. A—Synthetic Resins Phenol-Formaldehyde			
a. Molded	Miscellaneous forms	Molded machine parts of all descriptions, decorative	Arcolite, Bakelite, Durez, Durite, Haveg, Makalot, Resinox, Richware, Pyroplax, Textolite
b. Laminated	Sheets, rods, tubes, bars, fabricated parts	Bearings, gears, decorative, impact members, frames, cams, panels, insulating, etc.	Aqualite, Formica, Synthane, Micarta, Celeron, Textolite, Insurok, Campbellite, Panelyte, Phenolite, Dilecto, Vulcoid, Spauldite, Lamicoid, Ohmoid
c. Cast	Sheets, rods, slabs, tubes, bars	Decorative, knobs, housings, machined parts	Catalin, Catalagulli, Marblette, Fiberlon, Ivaleur, Panplastic, Joanite, Jewelin
B—Synthetic Resins Urea-Formaldehyde			
a. Molded	Miscellaneous forms	Decorative, housings, colored parts	Beetle, Cibanoid, Harvite, Crystalite, Luxite, Plaskon, Richelain
b. Laminated	Sheets, rods, tubes, bars, parts	Decorative, panels	Cibanoid, DilectoUF, Formica, Moldarta, Phenolite
c. Cast	Sheets, rods, bars	Decorative	Crystus
C—Synthetic Resins Miscellaneous			
a. Acrylic Resins	Sheets, rods, tubes	Decorative, transparent cover	Plexiglas, Paraplex
Acrylic Resins	Molded	Decorative, acid-resistance	Pontalite, Acryloid
b. Vinyl Resins	Molded and sheet	Decorative, colors, cabinets, transparent	Vinylite
c. Glyceryl & Phthalic Anhydride	Molded and sheet	Elec. insulation, transparent	Glyptal
d. Styrene Resins	Molded	Best electrical insulating props., radio equipt.	Victron
III. Proteins			
a. Phenol-Furfural	Molded	Various, thin wall moldings	Durite
b. Soya bean meal	Molded	Automotive parts	Soya Bean (Ford Motor)
c. Casein	Sheets, rods, tubes	Small parts, decorative	Aladinite, Ameroid, Karolith
IV. Natural Resins Petroleum derivatives			
Resin	Molding compositions	Elec. parts, high temps (some)	Gumman, Cetec, Thermoplax, Pyroplax, Komac, Stanolite
Asphalt			
Pitch			
Shellac			
V. Synthetic Rubbers	Various	Protective coatings, etc.	Thiokol, Neoprene (formerly Duprene)

when the occasion arises, it is to the advantage of the designer to specify a plastic housing which is in keeping with the popular tastes.

There are a large number of examples of machines which have been modified externally to include plastic housings. The advantages claimed for these modifications are increased sales appeal, decreased weight and a permanent finish which will resist erosion and will not chip. The urea and phenol formaldehydes and the cellulose derivatives fulfill these requirements without any difficulty. Where an attractive color scheme is desired, urea-formaldehyde and the cellulose derivatives are available in all color schemes. Of the cellulose derivatives, the cellulose acetate is the preferred because it is not flammable, whereas the cellulose nitrate is.

Unlimited design possibilities exist in "streamlined" shapes and curved surfaces which are molded more easily than square edges. For dark finishes, such as may be applied as covers for small motors, and electrical appliances as telephone headsets, switch housings, distributor housings, etc., the phenol-formaldehyde and the darkly colored cellulose acetate plastics are used.

It is advisable to discuss the physical and chemical properties of plastic materials before going into details of the applications to machine design. As may be seen from TABLE I, the great majority of the plastics may be divided into the molded products and the laminated products, depending upon the method of manufacture. For the most part, the laminated products are confined to the phenol and urea-formaldehyde resins, particularly the former. These plastics are significant in the design of machinery inasmuch as the phenol-formaldehyde laminated plastics exhibit the best strength characteristics. Numerous examples of bearings, cams, gears, etc. of phenol-formaldehyde laminated plastics will be cited later. A group of laminated plastics are shown in Fig. 1. They are manufactured in sheets, tubes, bars and fabricated parts.

Dielectric Has Many Advantages

The advantages of a solid dielectric, which may be drilled, tapped, sawed, sheared, riveted, reamed, turned, ground, polished, beveled and engraved, are numerous, particularly in designing parts. As a matter of fact their use may not be confined necessarily to the electrical part of the design. For example, some enterprising manufacturers have found it expedient to mount the entire brush rigging of small motors upon a laminated plastic base, fulfilling mechanical and electrical requirements for the entire brush assembly simultaneously. The laminated plastic base referred to was made as one continuous fabricated part which was attached to the motor frame. Aside from electrical applications, there are numerous mechanical advantages associated

TABLE II

Physical Properties of Laminated Plastics

Material	Weight lbs./cu. in.	Tensile Strength pounds/sq. in.	Compressive Strength lbs./sq. in.	Water Absorption % in 24 hrs.	Dielectric Strength (Inst.) volts per mil	Heat Resistance degrees Fahr. (max. service temp.)	Machinability
Cellulose Nitrate	.056-.06	2,000 to 9,000	.....	3.0	300-780	150	Good
Cellulose Acetate	.048-.050	3,000 to 9,000	4,000-16,000	3.0	500-1000	150	Good
Phenol—Molded ..... Woodflour Filler	.048-.055	6,000 to 10,000	20,000-36,000	0.2 to 0.6	300-500	300	Fair to Good
Phenol—Molded ..... Mineral Filler	.068-.072	5,000 to 10,000	18,000-36,000	.01 to .15	200-400	500	Fair
Phenol—Molded ..... Fabric Filler	.050	6,500 to 7,500	20,000-32,000	1.0 to 3.0	300-450	300	Fair
Urea—Molded ..... Cellulose Filler	.055	5,000 to 13,000	24,000-35,000	.4 to 4.0	100-400	225	Fair
Phenol—Furfural ..... Molded—Woodflour	.050	5,000 to 12,000	28,000-36,000	.3 to .60	400-600	275	Fair
Phenol—Laminated ..... Grade X	.050	9,000 to 12,500	.....	3.0 to 6.0	500-700	300	Fair
Phenol—Laminated ..... Grade XP	.050	6,000 to 8,000	.....	3.0 to 6.0	500-600	300	Good
Phenol—Laminated ..... Grade XX	.050	6,000 to 8,000	.....	1.3 to 2.0	500-700	300	Fair
Phenol—Laminated ..... Grade XXX	.050	5,000 to 7,000	.....	1.0 to 1.2	500-650	300	Fair
Phenol—Laminated ..... Grade C	.050	7,500 to 10,000	35,000-38,000	1.5 to 2.5	100-150	300	Good
Phenol—Laminated ..... Grade CE	.050	7,500 to 9,500	34,000-36,000	1.25 to 1.75	150-450	300	Good
Phenol—Laminated ..... Grade L	.050	7,000 to 10,000	30,000-35,000	2.0 to 2.5	100-150	300	Good
Phenol—Laminated ..... Grade LE	.050	6,500 to 9,000	33,000-37,000	1.2 to 1.8	400-500	300	Good

with laminated plastics which will be discussed after a description of the various grades available.

In the manufacture of laminated plastics, rolls of paper or textiles are saturated with the thermosetting resin in a continuous process. These are cut into sheet size and placed one on top of the other. They are then placed between the platen of a press and cured under heat and pressure. The resin is polymerized into an infusible solid mass, forming a sheet or slab. Due to the complete penetration of the resin it is not possible to separate the individual laminations. Ten-inch thick sheets have been manufactured, and tests indicate uniformity of properties. Of course, the thicker the sheet becomes the longer the time necessary for curing the sheet. Much the same procedure is followed in making laminated tubes, with the exception that they are wrapped about a mandrel and placed in a semicircular mold, or cured in a separate oven.

A wide variety of grades of laminated plastics are available, and for the convenience of the machine designer the following tabulation of the standard grades is given with a short description of each type:

(1) Grade *X*—Paper base, laminated plastic. Is suitable for general electrical and mechanical properties. Does not absorb oil and is generally applied in insulating parts, as switchboard panels, washers and bushings.
(2) Grade XP—Paper base, laminated plastic. Designed primarily for punching operations.
(3) Grade XX—Paper base, laminated plastic. Possesses good mechanical properties and a high gloss, good appearance surface finish. Rag paper base is employed.
(4) Grade XXX—Paper base, laminated plastic. Noteworthy in its low moisture absorption. Fulfills exacting electrical requirements.
(5) Grade C—Canvas base, laminated plastic. Characterized by its high mechanical strength and impact resistance. Is suited for applications involving considerable mechanical shock.
(6) Grade CE—Canvas base, laminated plastic. Somewhat similar to grade C except that the electrical properties are improved.
(7) Grade L—Fine cambric base, laminated plastic. Recommended for all fine machining operations. Used extensively for intricate punchings and small gears.
(8) Grade LE—Linen base, laminated plastic. Similar to grade L with the exception that the electrical properties have been improved.

There are other bases for laminated plastic which have not been standardized as yet. Noteworthy among these are the heat resistant, asbestos fabric base, laminated plastics. Others feature various pastel shades, walnut grains and mahogany grains.

Gears and Bearings—Canvas base laminated phenol-formaldehyde plastics have gained considerable prominence in their applications to gears and bearings. Much has been written lately upon plastics bearings ("Phenolic Plastics for Bearing Materials," MACHINE DESIGN, Sept. and Oct. 1936, and "Kunstharzlager, gegenwartiger Stand," *Kunstoffe,* Oct. 1936) and to avoid repetition not much will be stated here outside

TABLE III
Molding Properties of Plastic Materials

Material	Molding Qualities	Mold Shrinkage (Inches/inch)
Phenol—Molded Wood flour	Excellent	.006 to .100
Phenol—Molded Mineral	Excellent to fair	.002 to .006
Phenol—Molded Fabric	Good to fair	.003 to .007
Cellulose Acetate	Excellent	.0025

of the fact that in certain applications bearings of laminated plastics have proved to be immensely superior to other types of bearings. The period of replacement in these cases is reported to be greatly lengthened. Water lubrication has supplanted oil lubrication in some of the installations. The reader's attention is invited to either of the referenced articles for more complete information on plastic bearings.

Gears and pinions of laminated plastics have been applied to large and small machines with success. The chief advantage lies in the silent operation accompanying gears of this material, with the psychological benefit of increased efficiency on the part of the machine operator. In addition, a longer life than with metallic gears and much smaller lubrication requirements are benefits accruing from some applications.

Material Possesses High Strength

The selection of laminated plastic, canvas base, for heavy duty gears and pinions is obvious after an examination of TABLE II, and the physical properties of these materials. It will be noted that this type possesses great strength, as compared with other types, and in addition it has the highest impact resistance. These characteristics make this plastic useful in the design of various cams, latches and other impact parts. For example, in the timing gear of a distributor the revolving breaker trip is subject to repeated impact loading which is adequately met by a part fabricated from laminated plastic.

It will be noted that these applications appear to the best advantage when the parts of the machine are free from grit or other deleterious substances tending to abrade the surface of the plastic. The set of curves in *Fig.* 3 gives some idea of the comparative abrasion resistance qualities of typical plastics. Under the same conditions the loss in weight of a steel sample was virtually zero. The superiority of the vinyl resin over the others in abrasion resistance is noteworthy.

Panels of Laminated Plastic—Decorative panels of laminated plastic add to the attractive appearance of a machine. The panels may have some legend or title etched upon the surface. A high gloss finish, such as that accompanying some of the paper base, black laminated plastics is entirely suitable. The high gloss finish may be obtained by using highly polished steel platen in the manufacture of the laminated plastics.

Fabricated Parts—Comparatively thin stocks of laminated plastics may be punched cold to form small, flat

machine parts of all descriptions. Heating facilitates the punching of thicker stock. Frames, insulating strips and separators, small washers and parts answering a variety of purposes fulfill the demands of the machine designers. By referring to the tabulation of the types of laminated plastics it is possible to select the grade best suited to a given job.

Pulleys—Small and large pulleys of laminated plastics are available for fulfilling certain mechanical functions of various designs. A number of pulleys are standard with plastic manufacturers. They are usually furnished with ball bearings in order to minimize friction.

Molded plastics play an important part in the design of various machine parts. Their versatility in improving the external appearance of commercial machines has been described already. It is proposed now to discuss those features which are of engineering value, and applicable to machines by reason of their extraordinary electrical, chemical or physical properties. As with the laminated plastics, there are various types of fillers used to impart different characteristics to the resins, though in the molded plastics the fillers are homogeneously distributed throughout the material rather than in layers. Distinct properties are associated with each filler, and for this reason the fillers will be discussed in turn, with emphasis upon those of special significance to machine design.

Wood Flour Filled Plastics—The wood flour filler is the most frequently used material for molded products, furnishing good average properties. This filler is used particularly in electrical parts, as radio tube bases, bushings, switch plates of complicated patterns, telephone headsets, etc. Good machining properties are exhibited by these materials.

Asbestos Filled Plastics—This group is distinguished by its high heat resistance. Certain products in this group have been known to withstand temperatures in excess of 500 degrees Fahr. for short periods of time.

Shredded Fabric Filled Plastics—In order to fulfill certain impact resistance requirements, fabric filled plastics have been made available. They possess an impact strength considerably superior to that displayed by other types. They do not machine as satisfactorily, however, as the wood flour filled type.

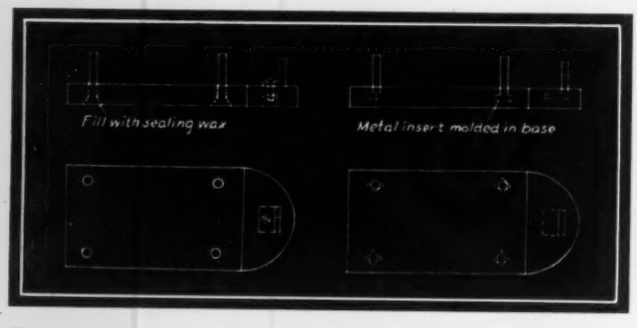


Fig. 4—Reduction in cost can be achieved by molding metal inserts into plastic parts

Miscellaneous Fillers—There have been a large number of miscellaneous fillers used with considerable success. One of the most prominent is graphite, which in 10 per cent proportion to the other materials has afforded products with low coefficient of friction. This has been satisfactory for such machine parts as small frictionless bearings of the self-lubricating type. It has also been applied to latch bolts, building hardware, automobile door bumper shoes, etc. Miscellaneous fillers such as slate powder, glass wool, china clay, rock powder, and chalk have been tried. Heat resistance and chemical resistance properties are reported.

As a guide to designers of molded plastic objects there are a few general rules to observe. The following practices should be avoided: Interior undercuts which prevent the removal of the upper part of the mold; long holes with thin walls; sharp inside corners; and horizontal side holes. It is less expensive to design the final object with letters sunk into the object rather than raised insignias. For those interested in close tolerances, TABLE III is offered as an indication of the molding qualities of the material and the mold shrinkage range.

Threads Can Be Molded

It is common to mold standard threaded objects with a great deal of consistent accuracy. The threads are perfect and entirely suitable for the purpose intended. The possible savings as a result of eliminating the machining operations are obvious. In addition, metal inserts may be molded directly into the piece or base during the molding operation . This eliminates several operations, as reference to *Fig.* 4 indicates. Drilling, countersinking, and assembly are completed in one operation. The design possibilities with metal inserts are numerous, and should do much to simplify the final product and lower costs.

The plastics are available in varnish form for application to metal surfaces for protective purposes. Thus, for example, a machine designer may be confronted with the problem of designing a pump to handle some acids or damaging chemicals. Metallic parts may be necessary for the most part. By adequate coating with the correct materials, he can provide durable finishes which will add greatly to the life of the equipment.

In conclusion, it is advisable to mention the more prominent of the transparent plastics as aids to machine designs. There is a present trend toward the adoption of dustproof, transparent covers for machine parts requiring frequent visual inspection. This saves time of removing panels, and perhaps shutting down of the equipment. Cellulose acetate and acrylic resins are quite satisfactory for this purpose. These are available in sheet form and can be drilled easily for attachment with machine screws. Thus it will be possible to examine some complex mechanism during operation without the danger of touching moving parts. Glass is unsatisfactory in some installations whereas the plastic described are practically unbreakable.

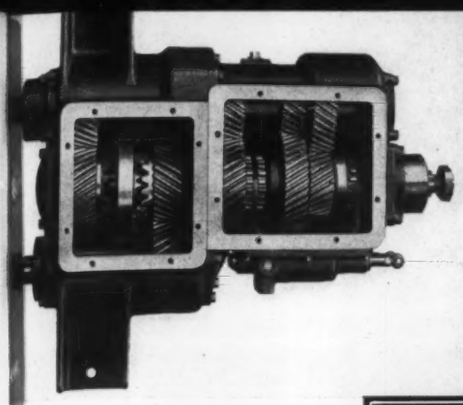
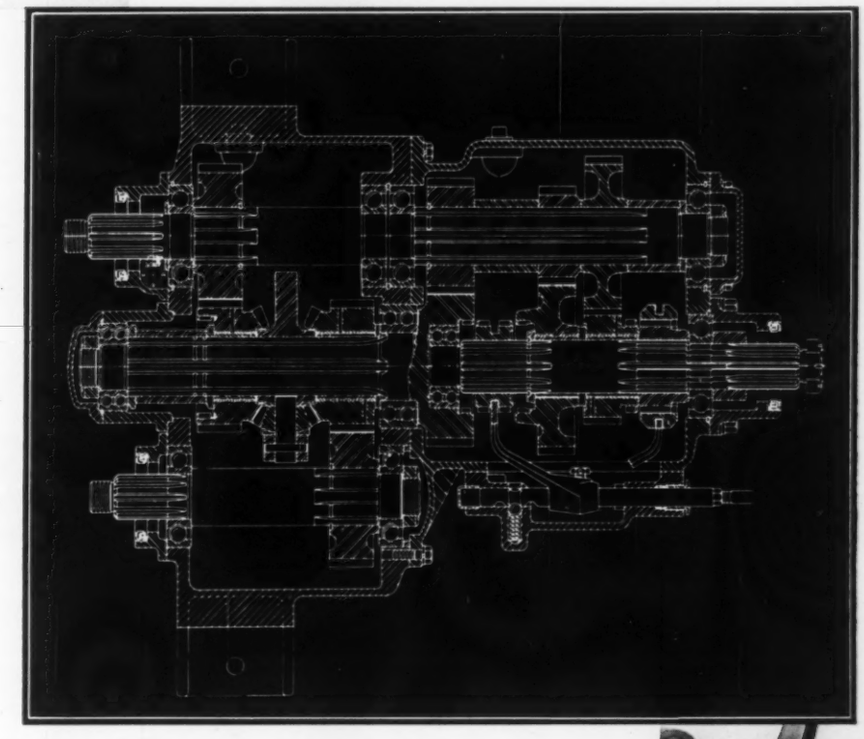


Fig. 1 — Left — Differential built into transmission makes possible double power take-off for dual-drive, six-wheel vehicle

Fig. 2—Below—Transmission also includes overdrive and underdrive unit, all the gears being of helical, constant mesh type



Differential Solves Dual-Drive Problem

EXCESSIVELY stringent operating conditions are often the usual thing with motor trucks. They may be required to operate through snow, deep sand or mud, off the highways, or over unimproved roads, and are always expected to perform satisfactorily even when carrying heavy overloads. A logical answer to this type of operating condition was the development of the dual-drive type of six-wheel vehicle where a standard axle and a trailing axle both receive power from a single transmission.

This arrangement gives the necessary extra traction, but in earlier models a difficulty was introduced due to confliction of the driving elements. The two axles had a tendency to "fight" when the truck traveled over rough surfaces, and differences in the tire size caused by different makes, various air pressures and wear increased this tendency. The problem is overcome in the new International dual-drive trucks of International Harvester Co. by the adoption of a third or auxiliary differential. In these trucks (*Concluded on Page* 55)

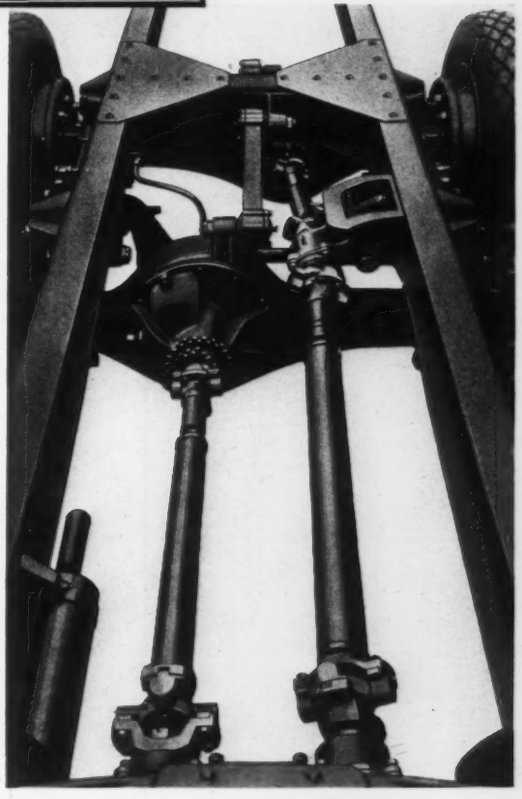


Fig. 3—Rear axles are mounted to retain true parallelogram form for all conditions

Unbalance at High Speed Is Successfully Combatted

By H. D. Else

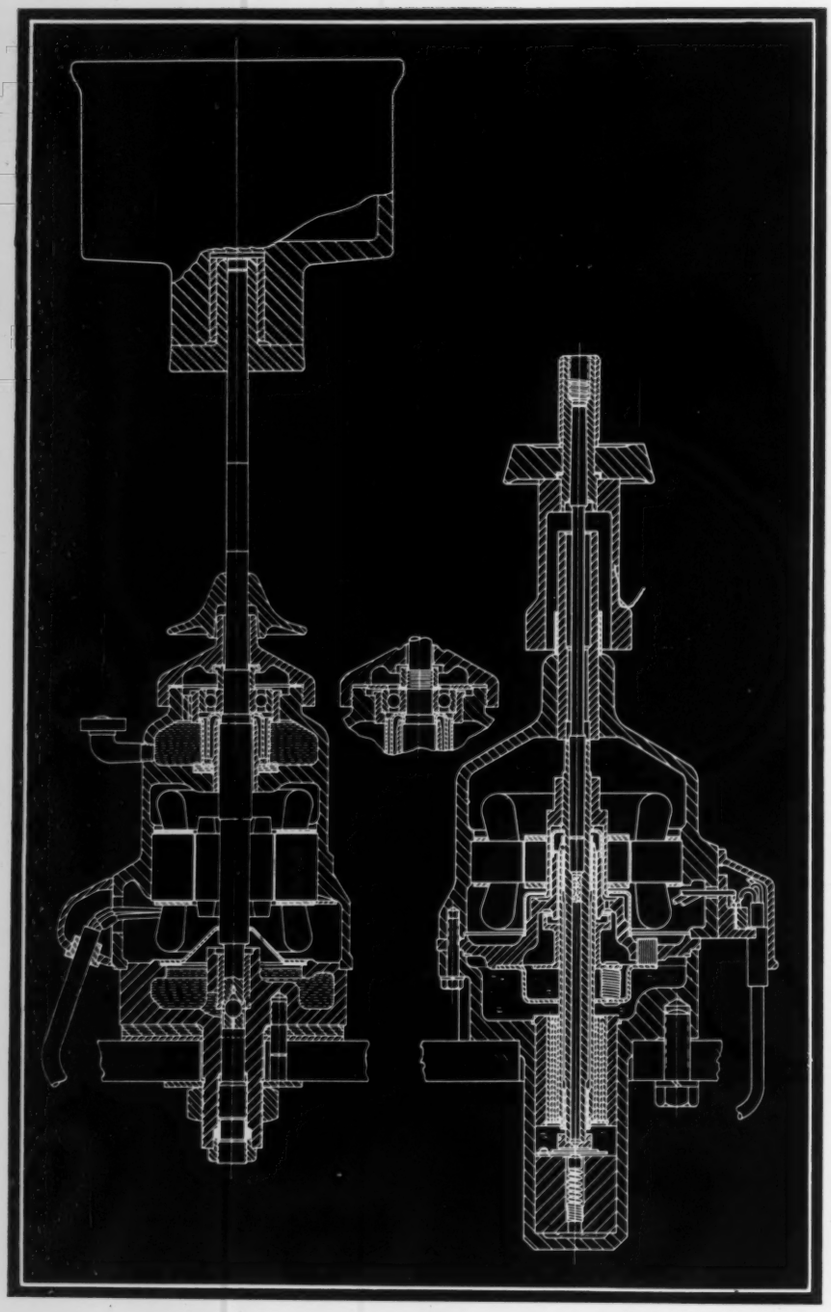


Fig. 1—Left—Spinning motor which runs above critical speed of compensation for purely mass unbalance. Right—one with special shaft and counterweight

DEVELOPMENT of the "Viscose" process of manufacturing rayon yarn created the need for a dependable, high speed, "bucket-spinning" motor. The solving of this bucket drive problem has involved an enormous amount of work on the part of research and design staffs of equipment manufacturers and close co-operation of the technical and operating groups of rayon producers. Requirements are: Continuous operation of a large number of units at high speed, with an unbalanced load, in an atmosphere laden with moisture and acid fumes. The location, immediately under the bucket compartment, imposes an additional hazard from liquid drip.

Speed and adverse operating conditions preclude the possibility of using gears or tapes. A special, totally enclosed, low voltage, high frequency, polyphase squirrel cage induction motor for each spindle therefore is the accepted drive. Speeds around 8000 revolutions per minute are in use on most new installations. Higher speeds are contemplated and motors are tested commercially at 10,000 revolutions per minute to determine acceptability. The process is continuous, twenty four hours per day, seven days per week. Once every four or six hours, the spindle is stopped for about one minute to remove the completed "cake" of twisted yarn and start another. In total number of revolutions, there is no parallel in industry to this application.

New buckets are carefully balanced, but after several months of use a total unbalance of 5 to 10 grams at a 3½-inch radius must be anticipated. The components of this unbalance are ordinary mass irregular-

ities, unbalance due to elastic deformation of the bucket parts at speed and unbalance resulting from the building of a cake on a bucket wall that is eccentric with the bore of the bucket bushing. If this problem were handled as a conventional rigid-mounted vertical motor, the upper bearing would be required to withstand a force of 300 pounds rotating at the speed of the motor. Bearings large enough to withstand this loading would have prohibitive losses and massive housings and supports would be required.

Several of the earlier spinning motors used three or four bearings and a two-piece shaft with a flexible coupling between the major portion and the spindle portion. The electrical elements were either rigidly supported or were mounted in a suspended casing of high inertia. The spindle bearings were flexibly supported. These motors were complicated and intricate, hard to repair and in general the structure precluded the possibility of a good lubricating system. In most cases they have been superseded by designs with only two guide bearings.

HERE we have a striking example of the eventual dependence of all branches of industry upon designers of machinery. It should not be overlooked that benefits from the development of these high speed drives discussed herein will accrue far beyond the rayon industry. For instance, designers of centrifugal separators will find in this account much of interest and value. The article is based on the personal experience of Mr. Else, who is connected with the Motor Engineering division, Westinghouse Electric & Mfg. Co., East Springfield, Mass.

Diagrams 2*a*, 2*b* and 2*c* of *Fig.* 2 illustrate an advance in design. In these diagrams *F* represents "Unbalance"; *G*, "Center of Gravity of Bucket"; *XX*, "Axis of Motor"; and *ZZ*, "Axis of Rotation." This motor is provided with a relatively long slender shaft extension. The left hand diagram of *Fig.* 1 shows a sectional view of a motor of this type. The critical speed between 2*a* and 2*b* of *Fig* 2 occurs at about 800 revolutions per minute. Between 2*b* and 2*c* of *Fig.* 2 it passes through another critical speed usually around 2500 revolutions per minute and operates with the relative position of the parts shown in 2*c* of *Fig.* 2.

If the driven member were a concentrated mass or a shallow bucket as shown in 3*a* of *Fig.* 2 the speed of motor dealt with in diagrams 2*a*, 2*b* 2*c* could be raised indefinitely without encountering further critical speeds until at some very high speed the individual

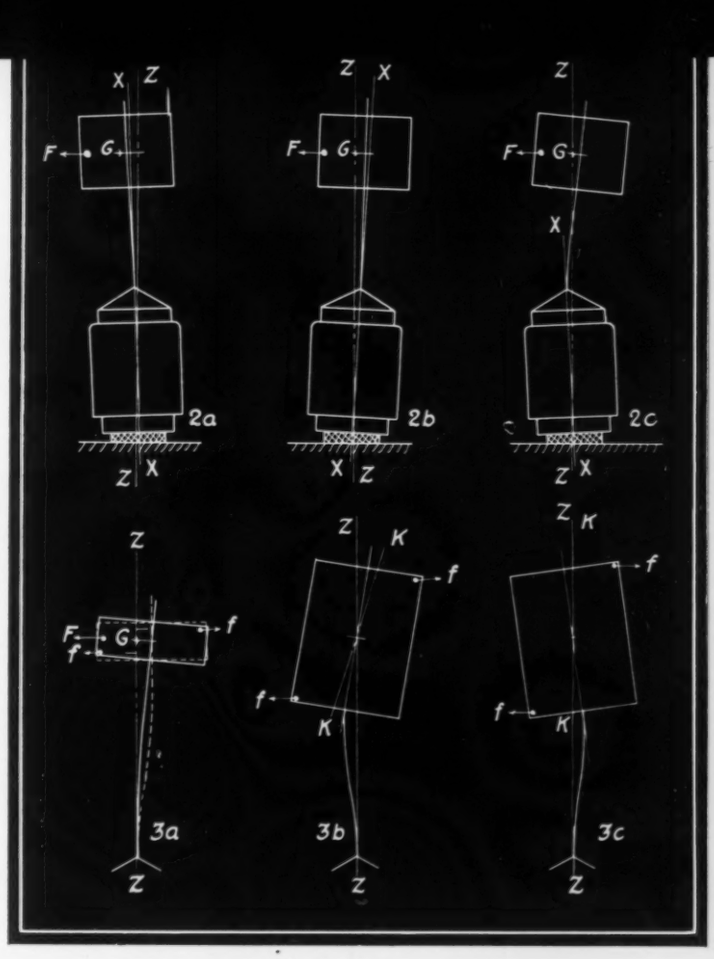


Fig. 2—Upper—Action of motor-bucket unit at various speeds
Lower—Effect of bucket mass

parts became resonant. Any unbalance couple, as *ff*, would be opposed by a couple resulting from the tilt of the disk and a state of equilibrium would persist. With increase in speed, the disk would approach the position of the dotted lines.

The action of a bucket of conventional depth is illustrated diagrammatically by 3*b* and 3*c* of *Fig.* 2. The unbalance couple *ff* produces an angular shift of the mass about a horizontal gravity axis of the bucket and in the same sense. With increase in speed a value is reached where the net moment which includes a gyroscopic effect of opposite sense increases more rapidly than the resisting moment of the shaft and the vertical gravity axis *KK* attempts to assume a position at a right angle to the axis of rotation. This is a critical speed. On the motor illustrated in the left hand diagram in *Fig.* 1 it occurs at 14,000 revolutions per minute. It was not found possible to drive this motor through the critical speed. On some motors of this general type the value was found to be as low as 9500 revolutions per minute.

In the motor shown in the right hand diagram in *Fig.* 1 the proportions and flexibility are chosen to place this critical speed below 2000 revolutions per minute and full speed operation as illustrated in 3*c* of *Fig.* 2 is obtained. The critical speed of mass effects occurs below 500 revolutions per minute. The speed of the motor may be raised indefinitely and the only load on the bearings is the resistance of the shaft to lateral and angular alignment of the gravity axis *KK* with the axis of rotation.

Minimum bearing loads are therefore obtained by the use of a slender shaft.

External damping which serves also as the motor support, as in the left hand diagram of *Fig.* 1, must be reasonably rigid to fulfill its proper function. A relatively heavy shaft is required to work such damping. The inertia of the motor housing also limits the slenderness of the shaft for if the shaft were light, the motor would act substantially as a rigid body. For a given unbalanced to be handled, an external damping system therefore requires a relatively heavy shaft and a massive counterweight, and the full advantage of running as in 3c is not realized.

Sleeves Provide Damping

The motor shown in the right hand diagram of *Fig.* 1 is provided with internal damping consisting of a group of concentric sleeves surrounding the lower end of the bearing tube and submerged in oil. Small clearances between the sleeves provide for the necessary movement of the oil when passing through the critical speeds. The motor will handle about 25 grams unbalance at the wall of a 7-inch bore bucket. Periodic adjustment and replacement of damping washers as used with motor shown at the left of *Fig.* 1 are no longer necessary. Failures of wound stators from vibration are eliminated as the motor housing is bolted rigidly to the rail. Even with large unbalances the bearings' loads are negligible.

A circulating system for accomplishing continuous limited oil feed is illustrated in left hand diagram of *Fig.* 1. The rotating flinger below the bearing is surrounded by a stationary baffle. In the bottom of the baffle are several small holes and below the baffle is a felt washer for straining the oil and restricting the flow through the pump mechanism. Under running conditions oil seeps slowly from the outer chamber through the felt washer and holes into the inner chamber. On touching the lower end of the flinger it is thrown outward in the form of a fine mist which rises through the bearing, collects and returns through a by-pass holes to the outer chamber. When shut down, oil rises in the inner chamber to the same level as in the outer one. This excess oil is scavenged in the first few revolutions.

Originally this motor was built with a thrust unit consisting of three hardened steel balls, in vertical series. After a reasonable period of service flat spots develop on the balls at the contacts. Oil can no longer reach the rubbing surfaces and the balls fuse together even though submerged.

The load which produces this welding action consists of the weight of the rotating parts plus a variable load resulting from unequal thermal expansion end wise between shaft and frame. To avoid hammering of the outer race of the ball bearing into the housing bore the fit is made relatively tight. By matching at assembly a push fit of about 40 pounds is obtained. This fit frequently tightens due to slight warping of the housing and the thrust ball may therefore be required to withstand a load of 75 to 100 pounds.

To avoid this expansion difficulty the construction shown in the supplementary view at the center of *Fig.* 1 has been adopted. In this construction the outer race of the ball bearing in the upper position is clamped endwise and the expensive matching assembly is avoided. The ball bearing takes the thrust and the lower end of the shaft is free. There are two objections to this arrangement. In dropping the bucket on the spindle a shock occurs which may produce ball denting. Secondly, with the ball bearing under thrust load all balls are continuously held in a fixed space relation with each other rather than free to respace themselves once every revolution. Minor inequalities of size consequently produce an increased load on the cage. This condition, while of little importance on ordinary applications, has some significance on a spinning motor due to the large number of revolutions involved. These objections, however, are more than outweighed by the correction of the expansion difficulty. The construction may also be handled by the use of a roller bearing in the upper position with either a ball bearing or a sleeve bearing in the lower position; or a free sliding ball bearing may be applied in the lower position with the upper bearing arrangement shown in the supplementary view at the center of *Fig.* 1.

Hollow Shaft Pumps Oil

The motor shown in the right hand diagram of *Fig.* 1 is provided with two sleeve guide bearings and a miniature Kingsburg-type thrust bearing consisting of two pivoted shoes spring supported to divide the load and to absorb the shock of dropping the bucket into position. The hollow shaft acts as a centrifugal pump drawing oil in through the hole in the bottom of the thrust runner and forcing it outward under pressure into the space in the bearing tube between the guide bearings. Oil overflowing at the top returns to the main chamber through the passages shown. Absence of metallic rubbing can be demonstrated by applying a low voltage to the shaft and frame of a well run in motor. When stationary current flows but at running speed the circuit is broken by the oil films. A single large oil chamber located below the winding eliminated the necessity of frequent attention, also, the possibility of oil soaked windings due to drip from an overhead bearing.

In spinning plants, buckets occasionally explode in the compartments. Unless the portion remaining on the spindle is reasonably symmetrical a bent spindle results. The motor shown at the right of *Fig.* 1 has a removable spindle to make possible a replacement on the frame. An added advantage of this construction is the fact that any major change in bucket proportions necessitating a change of spindle flexibility can be taken care of without dismantling the motor.

How Crane Bearing Meets Excessive Forces

By Clyde Hearne

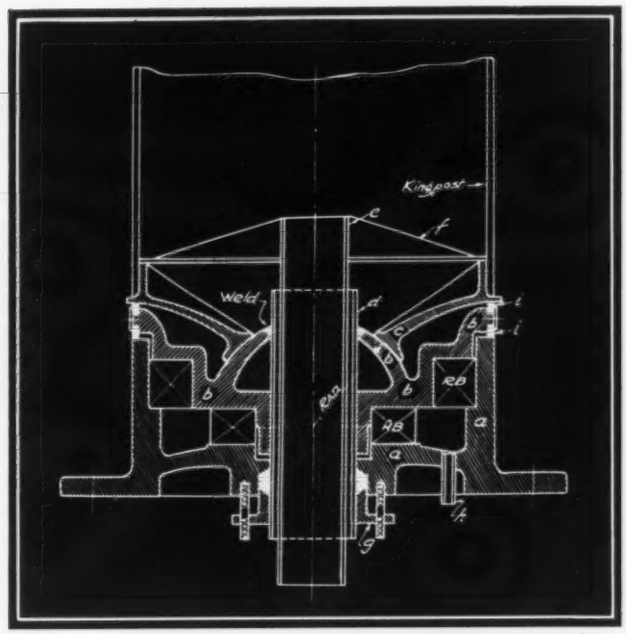


Fig. 1—Spherical seat construction of thrust bearing provides self-aligning feature

FORCES exerted on the kingposts of large cranes often become tremendous. Besides the weight of the crane itself with its heavy machinery, a load is often carried weighing several tons which may act on a moment arm 200 feet or more from the swivel bearing of the crane. To provide minimum turning friction in the swivel bearings and compensate for the unequal distribution of forces and loads acting on the kingpost a special thrust bearing has been designed.

The appreciable deflection of the rotating tubular kingpost together with the considerable loads to be carried calls for a self-aligning feature so designed that the thrust of the crane will be evenly distributed over all of the balls or rollers of the axial bearings. How this is accomplished in a crane recently developed is discussed in the following:

Fig. 1 shows the lower bearing which takes thrust and radial loads, while the upper bearing takes a radial load only. It is the self-aligning bearing of commercial, spherical seat construction which needs no description to the readers of this magazine.

In the illustration, *a* is the base which is provided with an oil filling connection and oil gage (not shown) besides the oil drain indicated as the pipe *h*. The oil level under service conditions should be at the top of the convex spherical seat on part *c*. Running the bearing in oil necessitates the gland *g* with its packing, and the oil seals *i*, *i*.

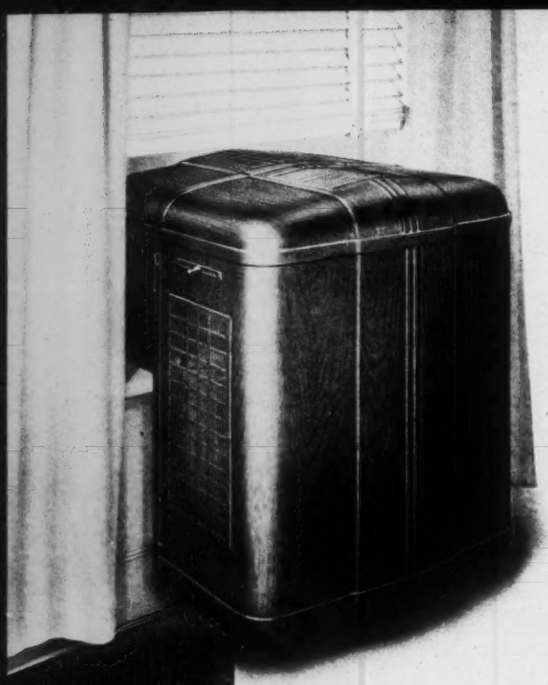
In the base *a* are housed the axial and radial bearings, AB and RB, respectively, both of which are antifriction; on and within these bearings rides the casting *b*, to which is welded the pipe *d* for oil chamber enclosure.

The convex spherical surface of *b* receives the corresponding concave surface of *c*, the two surfaces being ground together and *c* being provided with oil grooves. It should be noted that there is nothing to prevent a rotational movement of *c* with respect to *b*, and no doubt some such movement actually takes place. It is not anticipated, however, that this rotational movement will give rise to any difficulty unless *c* in the course of many years of service wears an annular groove in the face of *b* of such depth as to prevent free movement of *c* over *b* when the kingpost deflects, an extremely remote possibility.

Cables Carried Through Kingpost

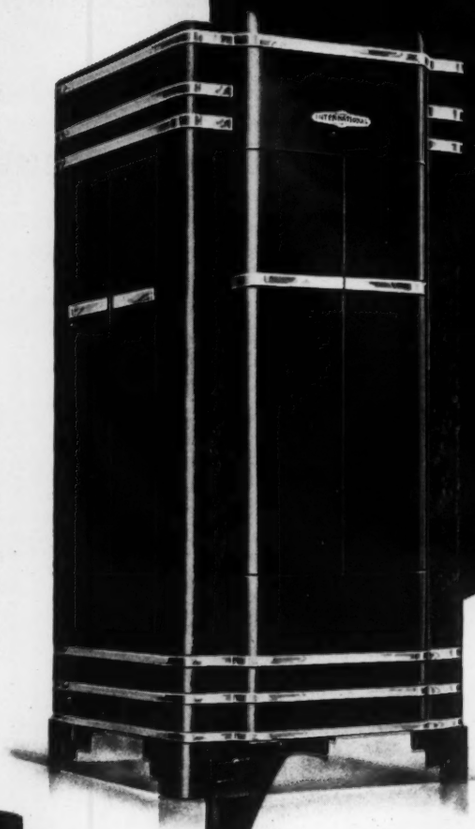
Seat member *c* carries through spider *f* the pipe *e*, which rotates with the kingpost. To the lower end of the pipe, collector rings and a brush rigging are fastened so that electric current may be carried in cables running within the kingpost without twisting the cables as the kingpost rotates. This arrangement was necessary because the turning and rotating machinery of the crane are carried on platforms welded to the kingpost.

Since the center of curvature of the spherical surfaces of *b* and *c* is at the center of the axial bearing, it follows that the resultant of the kingpost forces must pass through that center. The horizontal component of the resultant is taken up by the radial bearing, the vertical component by the axial bearing, the thrust load thus becoming evenly distributed. Obviously, the radius of the spherical surfaces must be such that there is no danger that *c* will tend to climb up on *b*, because of the horizontal force set up by moment of load hoisted times crane out-reach.

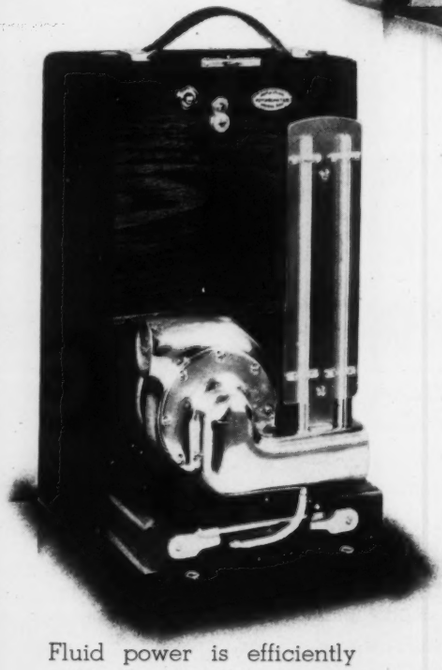


Rubber cushions mounted between working parts and frame make this neat Westinghouse air conditioner, left, unusually quiet in operation. The power is hermetically sealed in, and a special thermostatic control guards the motor against overheating.

Porcelain enameled finish and chromium trim serve to make this International oil heater, right, a thing of beauty. The patented white flame burner lights with a match and is silent in operation. An automatic draft regulator and constant level safety valve are important features.



Built-in motor-blower on this H-B psychrometer, right, assures an accurate relative humidity reading in one minute. Designed to operate on either house current or batteries the instrument is particularly useful in public places. A cross-flow air movement is used to minimize the effect of human breath and body heat on the instrument.



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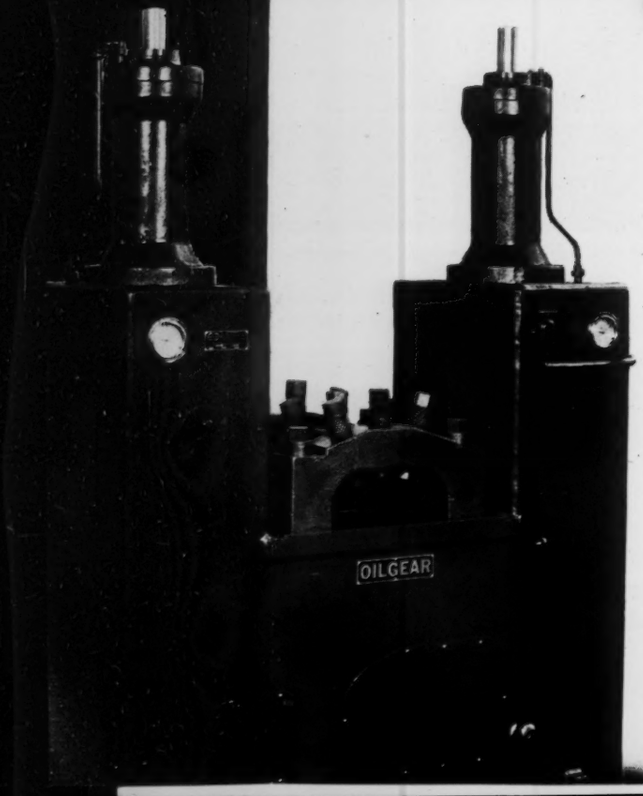
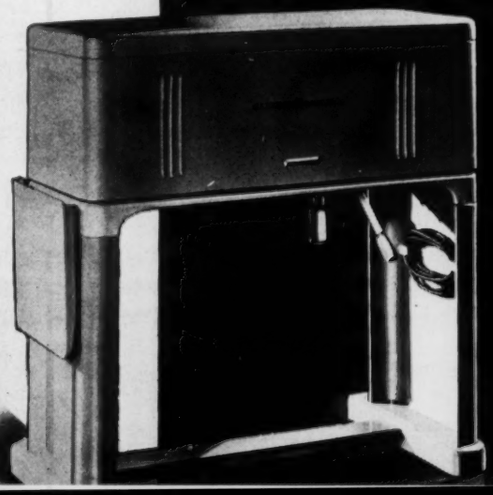


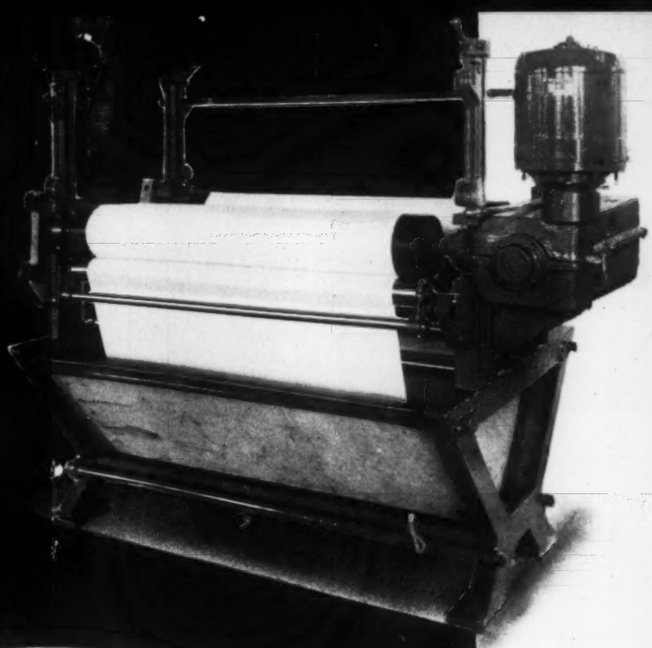
Fluid power is efficiently utilized in this Oilgear propeller twisting machine, left, which supersedes the manual method of obtaining propeller pitch. The three large screws shown in the illustration clamp the propeller while hydraulically-actuated cylinders turn it to shape.

A floating roll which moves to the ironer shoe instead of the latter's moving to it is one of the distinguishing features of this General Electric ironer, right. Thermostatic heat control simplifies ironing for the housewife who operates the machine by knee pressure.



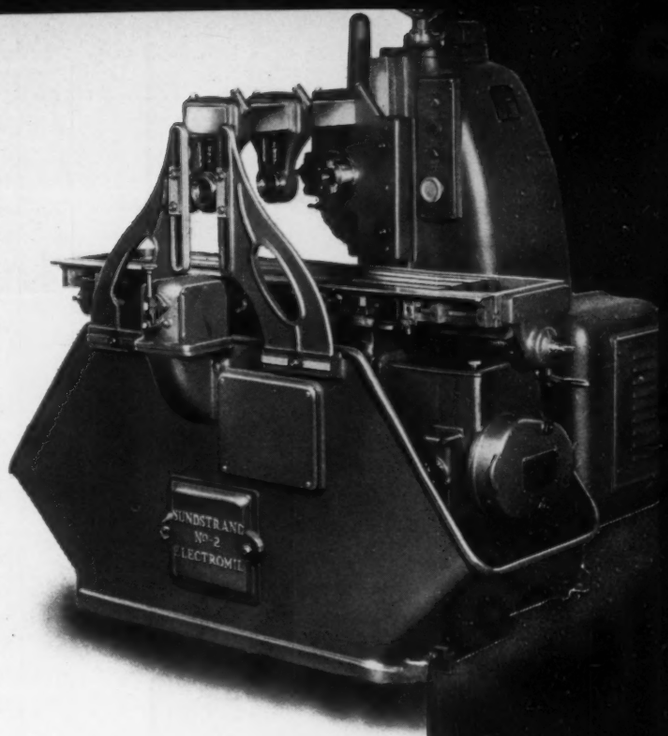
Features Machines

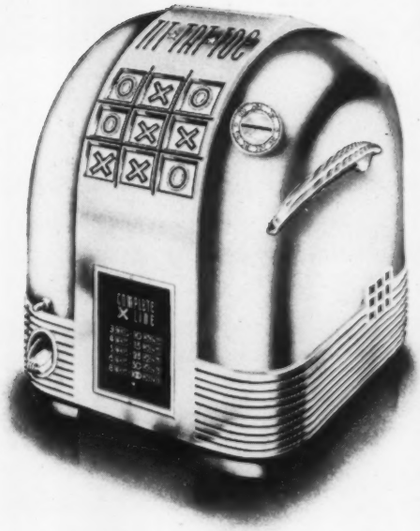
tation of Recent Machinery
tandpoint of Design.



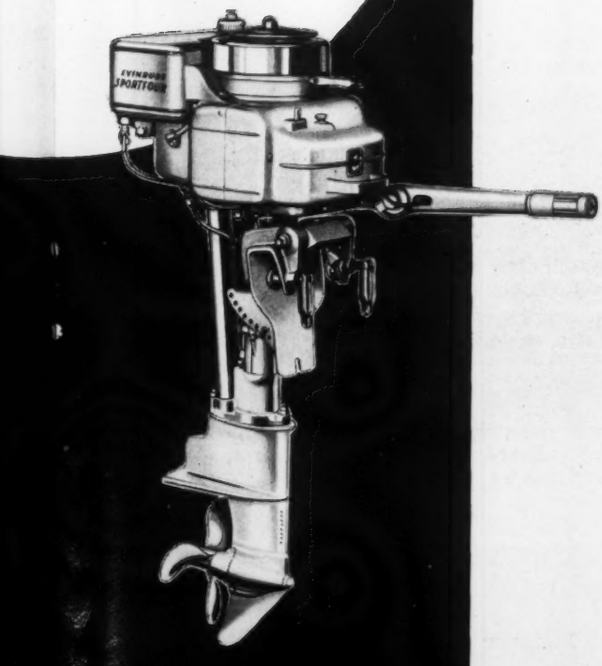
Stainless steel is used for the submerging roll bearings, brackets, and tub in this new jigger machine, left, built by Hinnekins for the textile industry. A double friction clutch is provided which gives a light starting torque and prevents tension of the goods.

Simplicity of tooling in the Sundstrand all - electric milling machine, right, makes it adaptable for many cutting operations. All table movements are governed accurately and dependably by a simple master switch. The base, column and saddle of the machine are an integral box-section casting.



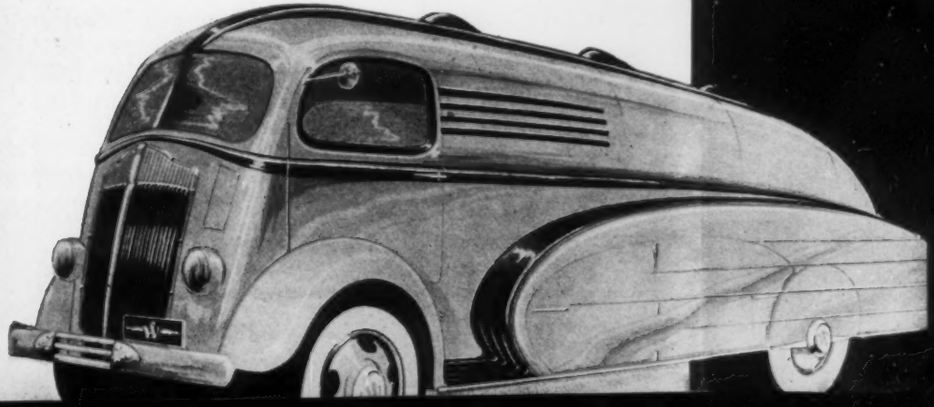


Aluminum alloy finish in this newly-designed Daval coin machine, left, tends to change it from an eyesore to an attractive device. The mechanism is adequately protected by the alumilite case and handling ease is facilitated by its reduced weight.



Two power impulses at each half revolution of the crankshaft result in extremely smooth operation of this four-cylinder Evinrude outboard motor, left. Aluminum and its alloys are used to reduce weight to a minimum. The propeller shaft grease seal is made with a steel ring on cork wedges.

Exceptional road stability and handling ease are incorporated into this cab-over-engine White truck, below. The front axle has been moved forward, giving better load distribution, and the tread widened considerably. Spring design permits an increase between spring centers of nearly a foot over earlier models.



New Machines Indicate Design Trends

Aluminum and its alloys are finding a wider and more important use in machines every day. Its lightness, resistance to corrosion and alloying characteristics make it one of the most desirable metals for the present day's lightweight parts. Street car bodies, airplane and household machines are a few of the types of equipment in which it plays a leading role.

Recently the boom of a large dredge was made of an aluminum alloy. By reducing the weight of the boom it was possible to use a dipper 50 per cent greater in capacity than if the structure had been made of a heavier material. Machines such as coin novelty units which are often moved employ aluminum or its alloys for many of their parts to facilitate handling. The suitability of aluminum for die or sand castings and machining further enhance its value to the machine designer today.

Machines recently announced in addition to those on the preceding two pages include the following:

Air Conditioning

Miles junior air conditioner for average home, Henry Furnace & Foundry Co., Cleveland.

All-in-one air conditioner for shops, stores and offices, Airtemp Inc., New York.

Automatic oil heating and air conditioning for average home, Gar Wood Industries Inc., Detroit.

Baking

Research laboratory electric bake ovens, Despatch Oven Co., Minneapolis.

Construction

Heavy duty truck shovel, Michigan Power Shovel Co., Benton Harbor, Mich.

Dairy

Milk can washer, Creamery Package Mfg. Co., Chicago.

Milk bottle hooders, Package Machinery Co., Springfield, Mass.

Domestic

Pressure oil burner, Timken Silent Automatic Div. of Timken Detroit Axle Co., Detroit.

Glass

Electrically heated furnace for annealing watch crystals, Gruenberg Electric Co. Inc., New York.

Industrial

Oil burner, Syncro-Flame Burner Corp., Hartford, Conn.

Electric furnace for high temperature melting, Detroit Electric Furnace Co., Detroit.

Instantaneous recording equipment, Recording Equipment Mfg. Co., Hollywood, Calif.

Pneumatic suction system for transporting bulk materials, Dracco Corp., Cleveland.

Laundry

Washing machine, Poland Laundry Machinery Co., Boston, Mass.

Metalworking

Drilling machine, Buffalo Forge Co., Buffalo, N. Y.

Spline shaft grinder, Fitchburg Grinding Machine Corp., Fitchburg, Mass.

Electric disk sander, Stanley Electric Tool Div., Stanley Works, New Britain, Conn.

Self-contained cylindrical grinder, Cincinnati Milling Machine and Cincinnati Grinders Inc., Cincinnati, O.

Mining

Self-rotated stopers, Gardner-Denver Co., Quincy, Ill.

Office

Numbering machine, American Numbering Machine Co., Brooklyn, N. Y.

Motor-driven letter opener, Multipost Co. Inc., Rochester, N. Y.

Packaging

High-speed machine for imprinting ends of boxes or shipping containers, R. Hoe & Co., New York.

Label paster, Alsop Engineering Corp., New York.

Petroleum

Centrifugal oil extractors, National Separator Co., Worcester, Mass.

Plastic

Hydraulic plastic injection-molding machine, Reed-Prentice Corp., Worcester, Mass.

Plumbing

Electric thawing machine, Commonwealth Mfg. Corp., Cincinnati, O.

Sewer cleaning machine, Roto Rooter Sales Co., Des Moines, Iowa.

Railway

Box car loader, for bulk materials, Link-Belt Co., Chicago.

Refrigerating

Refrigerating machine, Curtis Mfg. Co., St. Louis.

Restaurant

Electric fan and odor disseminator, Ira E. Baker Co., Cleveland.

Carbonating and filling machine, W. F. Armstrong Co., Chicago.

Rubber

Span grinding mill to reduce vulcanized rubber waste to powder form, M. Pancorbo, New York.

Welding

Arc welding machine, Hobart Bros., Troy, O.

Increased Application of Diesels Rests Upon Initiative of the Engineer

WITHOUT the metallurgist, or at least a close knowledge of production, characteristics and application of metals, the designer of machinery is extremely handicapped—symbolical of which is the fact that more and more machinery building companies are engaging the services of trained metallurgists to work in conjunction with design engineers.

Nothing could be more illustrative of this need for collaboration than the development of the diesel engine, the introduction of which to this country forty years ago was celebrated recently in New York. Comparison of the crude diesels of that time with present day engines is just as ludicrous as comparing Ford's original car with 1937 models—and it is the advance in metals and knowledge of their use that can be credited primarily for the development thus far effected.

Had Rudolf Diesel lived—he met an untimely and unexplained death through disappearance while on a steamship passage between Antwerp and England in 1913—he would have been amazed to find that production of diesel engines during 1936 practically doubled that of the previous year. In buses, tractors and marine vessels the application is most marked, and promises to continue at an even faster pace.

That there is still work to be done in the design of diesels for general application, however, besides the all-important aspect of the availability and selection of metals—is evident from the fact that attempts to enter the passenger automobile and airplane fields have met with only partial success. Someday even these applications may succumb to the resourcefulness of designers and the efforts of the producers of metals.

• • •

Functional Design!

WITH the justifiable trend toward smoothness of contour and styling of machinery, as brought about largely by the industrial designer, has come into existence a much-overworked term "functional design." The implication of the expression is, of course, that any machine shall, in appearance, be akin to the work it performs.

That there is much to be said for the idea is not denied—in fact one of the constant aims of the machine designer is to have his machine "look the part," consistent with good mechanical design. So much so, that it is hoped an overdose of "functionalism" will not be the means of causing the pendulum to swing too rapidly the other way!

Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Nomogram Solves Beam Equations

To the Editor:

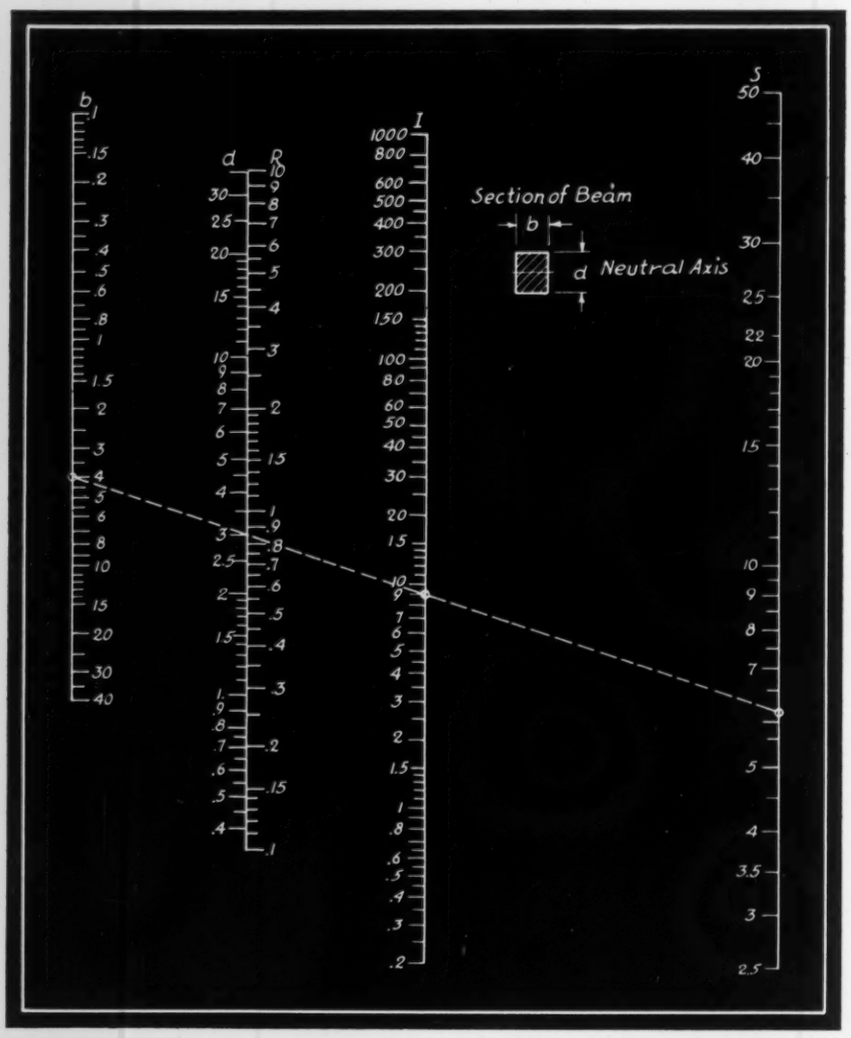
FOR the convenience of readers of MACHINE DESIGN who may be interested in a simple and compact method of finding quantities used in the calculation of rectangular beams and columns, I submit the accompanying nomogram which I have found to be a time saver in dealing with these problems.

In figuring the moment of inertia, section modulus or radius of gyration in beams, this nomogram solves the following equations:

$$I = bd^3/12,\ S = bd^2/6,\ R = d/\sqrt{12}$$

In these equations,

I = Moment of inertia with respect to the neutral axis of beam, inches^4.
S = Section modulus, inches^3.
R = Radius of gyration, inches.
b = Breath of beam.
c = Depth of beam.



Reference to nomogram quickly gives accurate results in beam calculations

For example, the secant drawn shows that for a beam 4 inches long and 3 inches deep the moment of inertia is 9, its section modulus is 6 and its radius of gyration is .87.

The chart is very compact, consisting of two superposed 3-scale nomograms having two scales doubly graduated. Thus the four vertical lines yield three quantities by the drawing of only one index line (or secant).

The moduli (inches length from 1 to 10) of the log scales on the original chart, reading from left to right, are: —2.5, 3.75, 2.5 and 7.5. Their distance apart are in ratio of 1:1:2, and their alignment is such as to make the secant passing through the values

shown, which were computed from the formulas, a straight line.

—CARL P. NACHOD, *vice pres.*,
Nachod U. S. Signal Co. Inc.

Gear Problems Are Simplified

To the Editor:

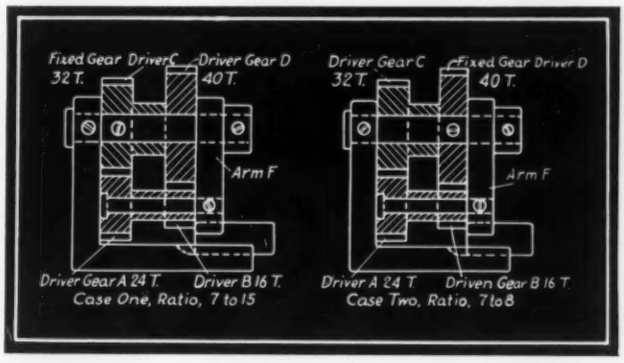
ALTHOUGH the solution of ordinary gear trains is part of the early training of every mechanical engineer, figuring of gear ratios of compound planetary gearing is often confusing. Such problems occur frequently in machine design today and a simple and easy method of solution should be welcome to designers. The two examples given here may be of aid to your readers.

The accompanying blueprints illustrate cases Nos. 1 and 2 which I have worked out below. The fixture upon which the gears are mounted merely takes the place of the regular parts generally used in planetary gearing.

Solution of case No. 1:

Product of teeth on driver gears = 16 x 32 = 512
Product of teeth on driven gears = 24 x 40 = 960
Then 1 − 512/960 = 7/15

which is the revolution of gear *D* for each revolution of arm *F*. Both gear *D* and arm *F* rotate in the same direction, or clockwise. If the product of the driver gears is less than the product of the driven gears, the direction of rotation of gear *D* and arm *F* will be the same.



Diagrammatic sketches of typical compound planetary gear trains

Solution of case No. 2:

Product of teeth on driver gears = 24 x 40 = 960
Product of teeth on driven gears = 16 x 32 = 512
Then 960/512 = 1, 448/512 = 1⅞ and 1⅞ − 1 = ⅞

which is the revolution of gear *C* for each revolution of arm *F*. Gear *C* rotates in an opposite direction to that of arm *F*, or counterclockwise. If the product of the driver gears is more than the product of the driven gears, the direction of rotation of gear *C* and arm *F* will be opposite.

—EDWARD J. RANTSCH,
Hollis, N. Y.

Differential Solves Drive Problem

(*Concluded from Page* 45)

the power is divided ahead of the driving axles by the use of a power divider, *Fig.* 2, which contains the third differential. A unique feature of this power divider is that it also includes an auxiliary overdrive and underdrive unit, all the gears of which are of the helical, constant-mesh type, lapped for quiet operation, *Fig.* 1. The overdrive permits higher speed without unnecessary engine revolutions as when returning without load or on level highways. The underdrive provides extra pulling power when needed.

Permits Maximum Flexibility

Developed as an integral part of the chassis, the fundamental principle of the mounting for the four rear wheels is retention of the true parallelogram form at all times and under all operating conditions; thus keeping the axles parallel to each other with fixed centers between them and the wheels parallel with the frame.

This mounting is designed to permit maximum flexibility without distortion, making possible free up-and-down independent movement of all four rear wheels so as to compensate for road irregularities without disturbing the distribution of weight between them or without interfering with equal traction. To accomplish this, the company makes use of equalizing beams pivoted with ball and socket joints through the ends of the housings of the two rear axles below the axle centers, *Fig.* 3. This feature permits the absorption of a large proportion of the starting, driving and brake torque by the vehicle and its load as well as the reduction of friction to a minimum and the practical elimination of torsional stress.

Welding Foundation Is Created

SCIENTIFIC research in arc welding should make rapid strides during the coming year with the establishment last week of a fund and foundation to encourage study in arc welding for the benefit of the industry. The new fund is made possible by Lincoln Elecertic Co., of Cleveland, and will be known as "The James F. Lincoln Foundation," taking its name from the president of the company.

Principal direction of the Foundation's work will be under Dr. E. E. Dresse, chairman of the department of electrical engineering of Ohio State University. Dr. Dreese is the author of numerous papers presented before the American Institute of Electrical Engineers and is a member of several electrical engineering societies.

MEN of MACHINES

FOLLOWING many years of design experience both in this country and abroad, D. J. Gregory has joined the hydraulic press division of A. B. Farquhar Co. Ltd., York, Pa., as chief engineer. This appointment comes at the time when this 80-year old manufacturing organization is expanding its press-building activities.

Mr. Gregory always has devoted his engineering talents primarily to the field of hydraulic presses. In Europe he followed out this work at the Krupp plants in Germany and at the Putilov works in Russia, while in the United States he has been connected with the Bethlehem Steel, Birdsboro, Farrel-Birmingham, and Baldwin-Southwark organizations. He has developed a wide variety of high-speed hydraulic presses for processing many materials, including metal, rubber, plastics, fibre, veneer and paper.

D. J. GREGORY

• • •

AT THE age of forty-one, Carl Kindle has been made general manager of the Delco Products division of the General Motors Corp., Dayton, O. Following his graduation from Carnegie Institute of Technology in 1917, Mr. Kindle began work in the starting, lighting and ignition section of Westinghouse Electric & Mfg. Co. Following out this same line of activity, he went to Anderson, Ind., in 1925, where he became a member of the ignition engineering staff of the Delco-Remy division of the General Motors Corp.

A year later he was transferred to the Delco Products division in Dayton as carburetor engineer. He was appointed chief engineer of Delco Products in 1929 and from January 1936 to the time of his recent promotion he had been factory manager.

CARL KINDLE

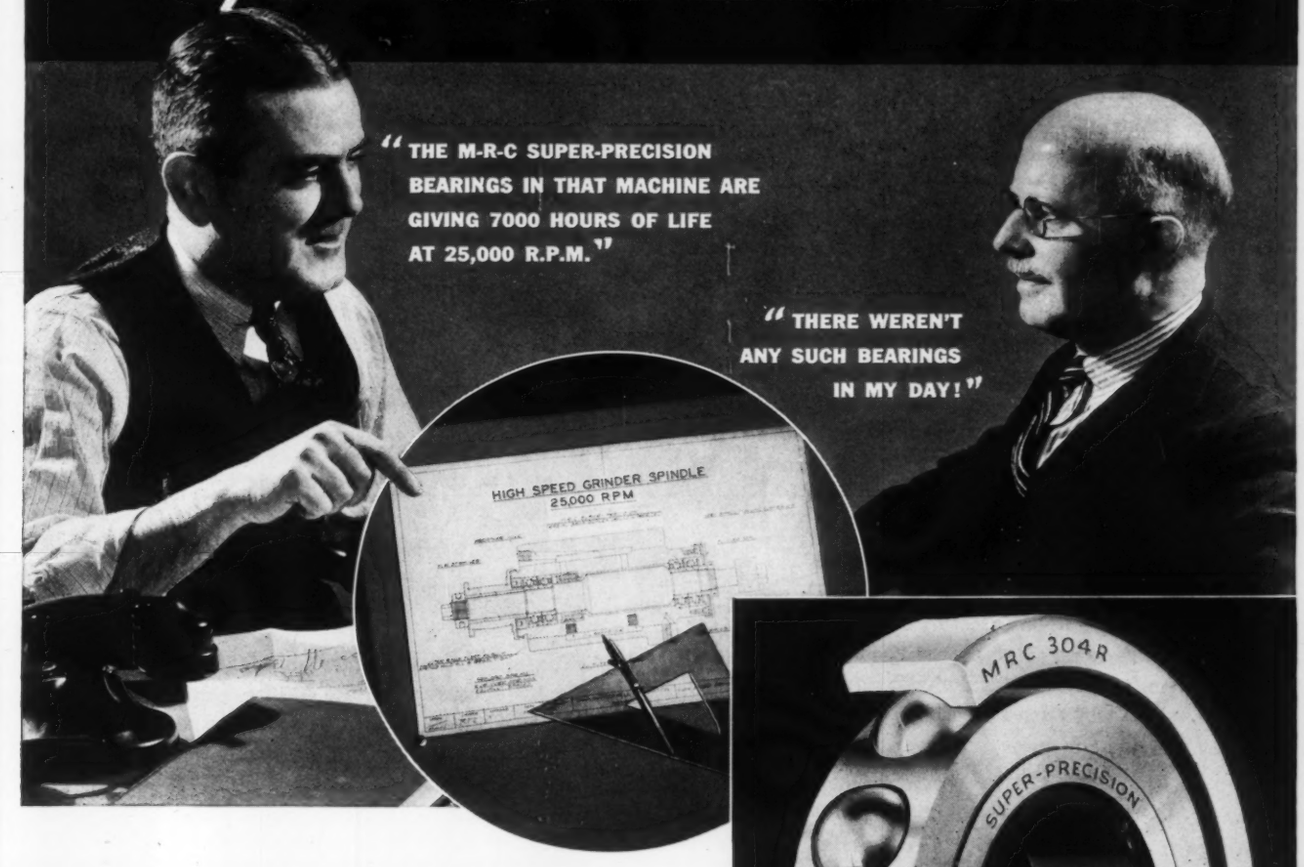
• • •

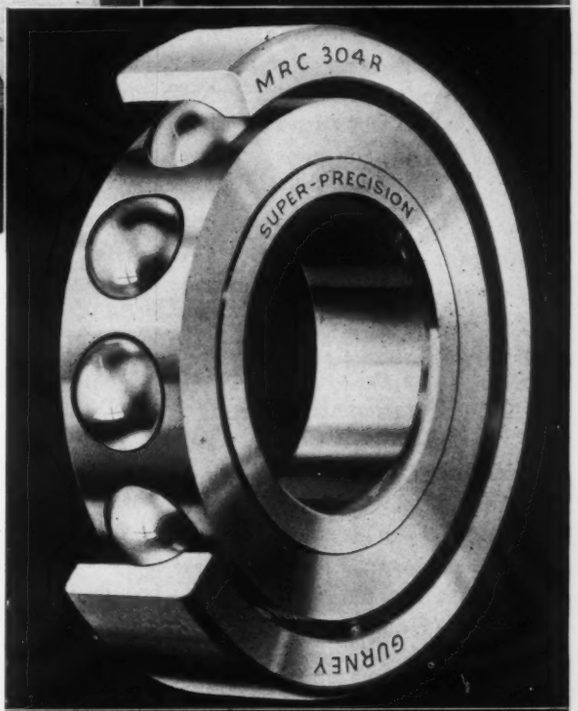
ROY E. COLE, vice president in charge of engineering of the Studebaker Corp., South Bend, Ind., is a man whose interests always have been centered in the automotive industry. The foundation of his mechanical engineering career was laid at Ohio State University and his first job was in the engineering department of the Oldsmobile company. Following this he worked for Chalmers, Peerless and Continental Motors, then in 1924 he joined the Dodge organization.

When the Dodge company was bought out by Chrysler in 1928, Mr. Cole went with Durant as chief engineer. Two years later he joined the Studebaker engineering staff and was in a large measure responsible for the design of the successful Rockne car. Mr. Cole's rise with Studebaker was rapid. He was made executive engineer in 1933, chief engineer late

ROY E. COLE

They said it couldn't be done!


"THE M-R-C SUPER-PRECISION BEARINGS IN THAT MACHINE ARE GIVING 7000 HOURS OF LIFE AT 25,000 R.P.M."
"THERE WEREN'T ANY SUCH BEARINGS IN MY DAY!"
HIGH SPEED GRINDER SPINDLE
25,000 R.P.M



M-R-C Super-Precision Ball Bearings were developed to meet the need for bearings that would give thousands of hours of service at very high speeds in production equipment. That they are doing this job successfully is proved by the many machines in service today getting satisfactory bearing life at speeds as high as 42,500 R. P. M. Learn what the M-R-C Super-Precision Ball Bearing will do for you.

MARLIN-ROCKWELL CORPORATION

Executive Offices: JAMESTOWN, N. Y.

Factories at JAMESTOWN *and* PLAINVILLE, CONN.

M-R-C Strom SRB Gurney Ball Bearings

M-R-C

Ball Bearings

GURNEY ● SRB ● STROM

in 1935 and was advanced to his present position in August 1936.

What his co-workers appreciate most about Roy E. Cole is his calm, unruffled dignity and his quick comprehension of their reports, their problems and their perplexities.

♦ ♦ ♦

D. L. MATHIAS has been appointed research engineer of Metal & Thermit Corp., New York. Mr. Mathias who was editor of *Heat Treating & Forging* from 1920 to 1927, had many years of metallurgical experience with the Mackintosh-Hemphill Co. and with Westinghouse Electric & Mfg. Co. He is the inventor of a number of welding electrodes and processes.

♦ ♦ ♦

TELL BERNA has been appointed general manager of the National Machine Tool Builders' association, Cleveland, succeeding Herman H. Lind who resigned recently to become executive vice president of the American Institute of Bolt, Nut and Rivet Manufacturers. Mr. Berna graduated from Cornell university with a degree in mechanical engineering.

♦ ♦ ♦

DONALD BLANCHARD, formerly editor of *Automobile Trade Journal,* has joined the staff of the Society of Automotive Engineers as secretary of the Engineering Relations committee. Mr. Blanchard graduated from Columbia university as an electrical engineer and subsequently worked for some time in the machinery field.

♦ ♦ ♦

GERALD R. BROPHY has joined the development and research staff of the International Nickel Co., with headquarters at the laboratory in Bayonne, N. J.

♦ ♦ ♦

JOHN L. DAVIDSON has been elected vice president of the Pilot Valve Co., New York, of which company he was formerly mechanical engineer.

♦ ♦ ♦

NORMAN B. JOHNSON has been appointed assistant chief engineer of the Pullman-Standard Car Mfg. Co., Chicago. He will have charge of mechanical engineering in all the plants of the company.

♦ ♦ ♦

ARTHUR S. HAWKES, formerly senior mechanical engineer, Naval Engineering experiment station, Annapolis, Md., has become associated with the Nordberg Mfg. Co., with headquarters at Milwaukee.

♦ ♦ ♦

CARL F. SCOTT has been appointed assistant to the manager, General Electric Co., Bridgeport, Conn., in charge of engineering.

♦ ♦ ♦

COMFORT A. ADAMS, professor of electrical engineering at Harvard university since 1906, is now engaged in professional engineering practice, with business headquarters at the Edward G. Budd Co., Philadelphia. Professor Adams, who is widely known as a consulting engineer, especially on electric welding, is past-president of the American Institute of Electrical Engineers and of the American Welding Society.

♦ ♦ ♦

HENRY M. HOBART, consulting engineer with the General Electric Co. for twenty-six years, has been awarded the 1935 Samuel Wylie Miller Memorial medal by the American Welding Society.

♦ ♦ ♦

ADRIAN MARMOR, has been appointed superintendent both of design and manufacture by the Hale Fire Pump Co., Conshohocken, Pa. Mr. Marmor was for several years a designer with the Autocar Co., Ardmore, Pa.

Obituaries

LEON CAMMEN, inventor, consulting engineer and associate editor of *Mechanical Engineering,* died in New York on Dec. 5 at the age of 61. Born in Kiev, Russia, and educated at the University of St. Petersburg, where he specialized in Oriental languages, Mr. Cammen subsequently became a member of the technical staff of the Russian diplomatic service and during the Russo-Japanese war was on the technical staff of the Russian army.

Mr. Cammen came to the United States in 1907 and obtained his Master's degree at the University of Illinois where he specialized in engineering and economics. Shortly thereafter he joined the staff of the American Society of Mechanical Engineers, of which he was chief technical consultant at the time of his death. Familiarity with fifteen languages made it possible for him to review technical literature from all parts of the world.

Of Mr. Cammen's numerous inventions, the most recent had to do with centrifugal casting of ingots, with oil refining and with teletype equipment.

♦ ♦ ♦

PROF. FRANK P. MCKIBBEN, engineer, educator and past president, American Welding Society, died recently at his home near Fayetteville, Pa. He was 65 years old. Born at Fort Smith, Ark., Professor McKibben devoted his career to engineering construction, writing and consulting work. He taught engineering at the Massachusetts Institute of Technology, Lehigh university and Union college for more than 22 years and formerly was consulting engineer for the General Electric Co.

* * *

CARL HENRY LEIS, chief engineer and factory manager, Johnson Bronze Co., died at his home in New Castle, Pa., on Nov. 11, at the age of 45.

Mr. Leis, who was born and educated in Germany, came to the United States in 1917 and had been associated with the Johnson Bronze Co. for the past ten years. He had a wide acquaintance among engineers and was recognized as an authority on bearings and bearing metal.

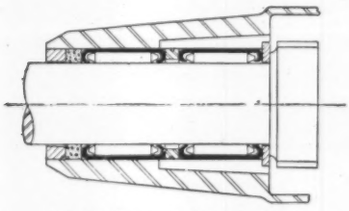
A New Bearing . . . of unusual merit

ADVANTAGES OF THIS NEW ANTI-FRICTION UNIT SHOW VALUE OF SIMPLICITY OF DESIGN. THE IDEAL BEARING SHOULD NOT BE COMPLICATED

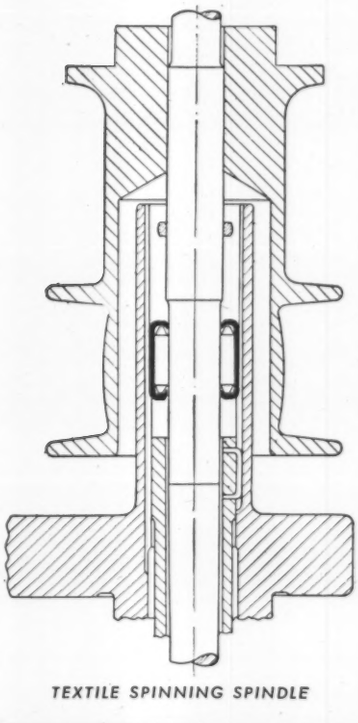
THE Torrington Needle Bearing represents a new development in modern bearing design. It combines all the features of an anti-friction bearing into a single compact unit that requires no more space than a simple bushing.

Two component parts—the full complement of relatively small diameter rollers and the retaining shell by which they are held—comprise the complete unit.

The advantages of this unit construction in facilitating installation, speeding assembly and permitting easy disassembly are readily apparent. In addition, the small size of the unit offers advantages. The small O.D. of the bearing simplifies the housing structure. The bearing, being a complete unit in itself, is simply pressed into position in a bore machined to proper dimensions. No auxiliary outer shell is necessary.



HAND DRILL SPINDLE HEAD



TEXTILE SPINNING SPINDLE

Practical Applications of The Torrington Needle Bearing Illustrate Its Unique Features.

High Radial Capacity

Of special importance is the high unit capacity of the Torrington Needle Bearing. For its size, it has a remarkably high radial load rating. This is obtained by the large number of rollers. For example, the full complement of needle rollers gives more than double the customary number of lines of contact with a directly proportionate increase in radial load carrying capacity.

The method of lubrication is another feature of the Torrington Needle Bearing. The retaining shell provides a natural reservoir for the lubricant and the clearance of .0025" between the turned-in lip and the shaft makes an effective seal. Thus the needle rollers turn in an oil or grease bath and continually bring up a fresh film of lubricant—insuring rotation of all moving members on a fluid film. The lubricating action of the Torrington Needle Bearing is as efficient as a *perfectly lubricated* plain bearing.

The size of the Torrington Needle Bearing coupled with the simplicity of its construction makes it a comparatively inexpensive anti-friction unit. Its small size greatly simplifies design and requires less material in surrounding members, contributing to further reduction in cost.

Experienced Manufacturing Methods

Drawing on the accumulated experience of over seventy years in the manufacture of precision needles of all types and twenty-five years of making ball bearings, the Torrington Company has built into the needle bearing the best that good engineering practice can produce. Exceptionally close tolerances are constantly met to insure continuous trouble-free operation under varying conditions and load requirements. The retaining shell which serves as the outer race, is drawn from accurately rolled strip steel, carefully heat treated and polished. Each roller is given an extremely high polish.

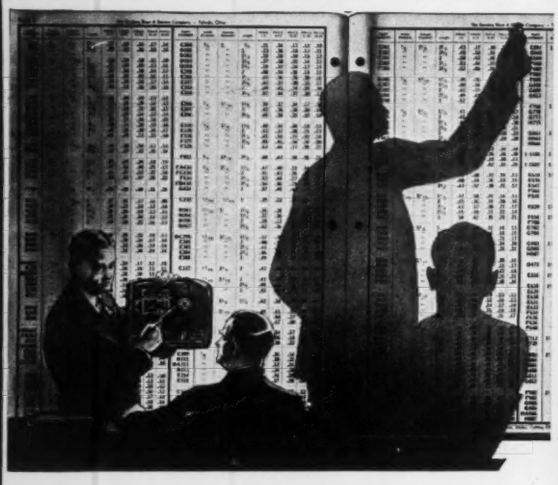
The shaft serves as the inner race in the majority of applications, and should be hardened and ground to proper dimensions. However, where it is desirable to use an unhardened shaft an inner race will be supplied. All bearings are packed with lubricant as soon as assembled. Every possible step is taken to insure perfection of materials and workmanship in the Torrington Needle Bearing.

A complete line of both bearings and inner races is available to meet the requirements of most commercial applications and immediate deliveries can be made from stocks on hand. Further information is available on request. Write for Catalogue No. 8.

The facilities of the Torrington Engineering Department are available, without charge, to all interested in adapting the Torrington Needle Bearing to their products. Manufacturers are invited to work directly with our engineering staff in developing assemblies and laying out applications.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Branch Offices in all Principal Cities

TORRINGTON
NEEDLE BEARING



"GET IT OUT OF STOCK"

TODAY when the need for bronze bearings is brought to executive attention the ruling invariably is "Get it out of stock."

There are more than 600 different sizes of these completely machined and finished standardized Bunting Bronze Bearings always in stock, meeting the requirements of practically every application.

Bunting also carries in stock at all times the bronze bearings, ready for assembly, required for all makes of electric motors from 1/40 hp to 60 hp.

Machined and centered 13" Cored and Solid Bronze Bars in 131 stock sizes, Anti-Friction and Genuine Babbitt are other Bunting stock products.

We will gladly place your name on our mailing list for complete catalog data on all these ready-to-use items. . The Bunting Brass & Bronze Company . . Toledo, Ohio.
Branches and Warehouses in All Principal Cities.

BUNTING Quality
BRONZE BUSHINGS • BEARINGS
MACHINED AND CENTERED BRONZE BARS
ANTI-FRICTION BABBITT

Noteworthy Patents

PATENT No. 2,030,027, issued to Henry B. Greenwood, Glenarm, Md., and assigned to F. X. Hooper Co., covers a method of caring for angular adjustment of shafts in respect to the driving gear. This is important in printing machinery for instance, wherein a roll often has to be brought into registry with the material with which it contacts.

A general idea of the Greenwood device is given by *Fig.* 1, in which the top view is a vertical section taken longitudinally, while the bottom view is a cross sectioned end view showing the internal gearing. In the longitudinal view, *A* is the motor actuating the ad-

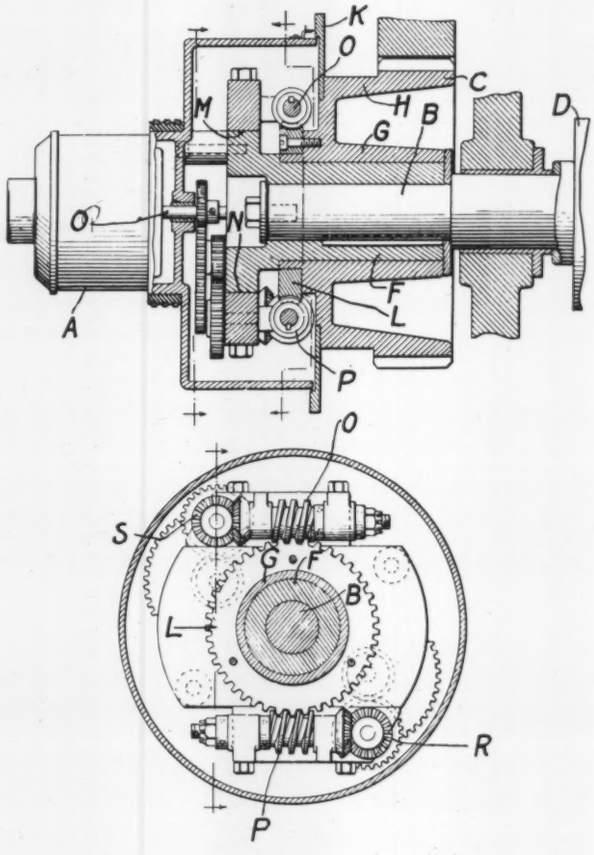


Fig. 1—*This device permits adjustment of rolls to exact register, without stopping machine*

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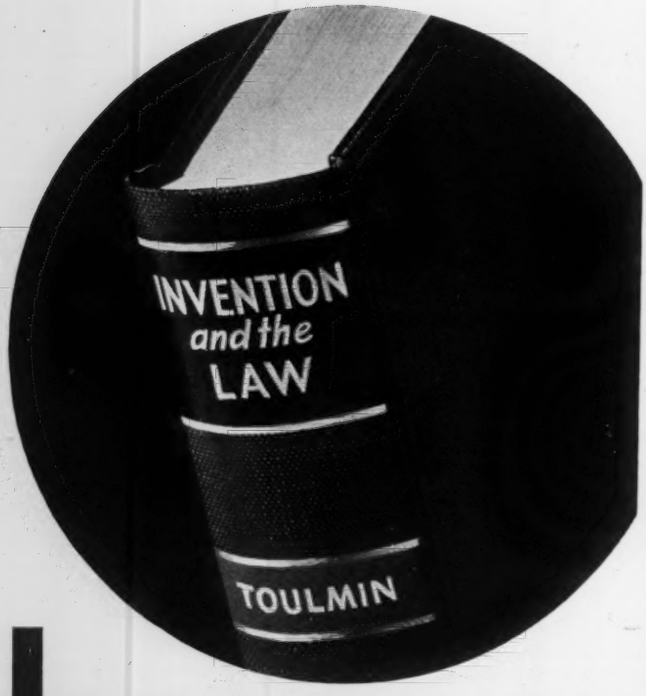

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justment mechanism, while in both views *B* represents the output shaft which requires angular adjustment in respect to its driving gear *C* which is one member of a gear train driving various members of a coordinated mechanism, in this case a printing press of which *D* is a printing cylinder.

Shaft *B* has keyed to it a sleeve *F*. Drive gear *C* is loosely mounted on this sleeve so that sleeve and shaft may turn in respect to it. The toothed portion of drive gear *C* is connected with its hub *G* by a web *H* which carries a flat ring *K* provided with a scale graduated to fractions of inches. This web *H* terminates in hub to which is bolted wormwheel *L*. Inner web *F* extends to the left beyond the end of shaft *B* and carries a flange on whose flat, parallel edges *M* and *N* are mounted bearing blocks carrying worms *O* and *P* meshing with wormwheel *L*. These worms serve to lock the driving to the driven members.

Angular adjustment of shaft *B* in relation to its drive gear *C* is obtained by simultaneous turning of worms *O* and *P*. This adjustment, which is read on scale *K*, is accomplished through shaft *Q* about which revolves a train of gears terminating in bevel pinions *R* and *S* meshing with similar pinions on worm gears *O* and *P*. Incidentally the blocks carrying the worms are adjustable lengthwise to take up any lost motion between the worms and their wheel.

Shaft *Q* actually is the rotor shaft of adjustment motor *A*, which is of reversing type. While its rotor normally revolves with the driven shaft of the mechanism, it is only energized when the operator closes its circuit to effect adjustment. When it is energized, the effect is to cause the worms to rotate in one way or the other, thereby advancing or retarding main drive shaft *B* in relation to its main drive gear *C*.

Aside from its ability to effect adjustment when the machine is running, it is pointed out that the symmetrical design of the mechanism gives it perfect balance even at high speed.

PATENT No. 2,059,675, covering an improvement in rotary vacuum pumps, has been granted to George H. Woodard of Phillipsburg, N. J., and assigned to the Ingersoll-Rand Co. This pump is shown in transverse section in *Fig.* 2.

A is a bored cylindrical casing, in which *B* is the intake and *C* the outlet. Within this casing is rotor *D*, whose centerline is above that of the cylinder bore, thus bringing rotor and bore in close proximity only at the top. Pumping is due to the set of sliding vanes *E* which constantly are pressed outward by springs into sliding contact with the bore.

This pump differs from conventional revolving piston types in that it has a system of valve-controlled ducts in its rotor. These ducts *F*, which are evenly spaced

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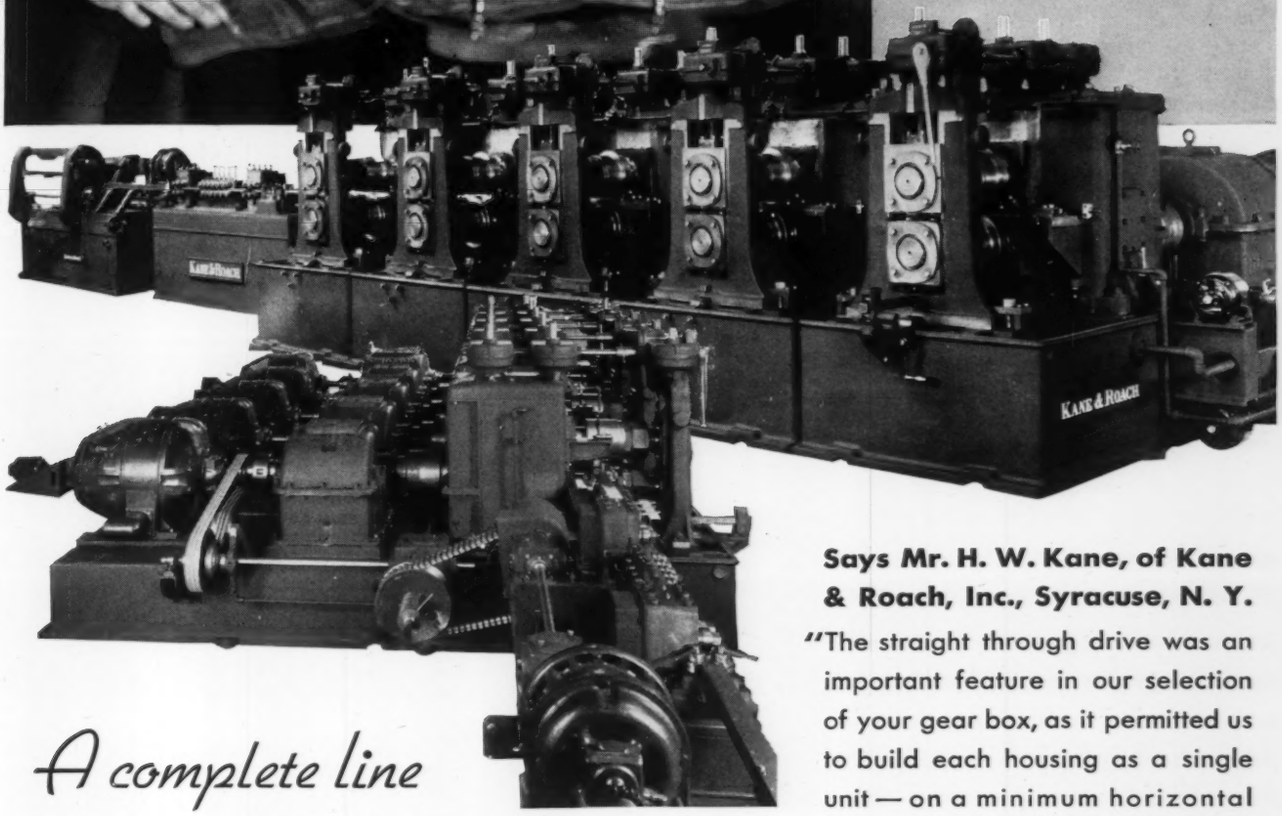

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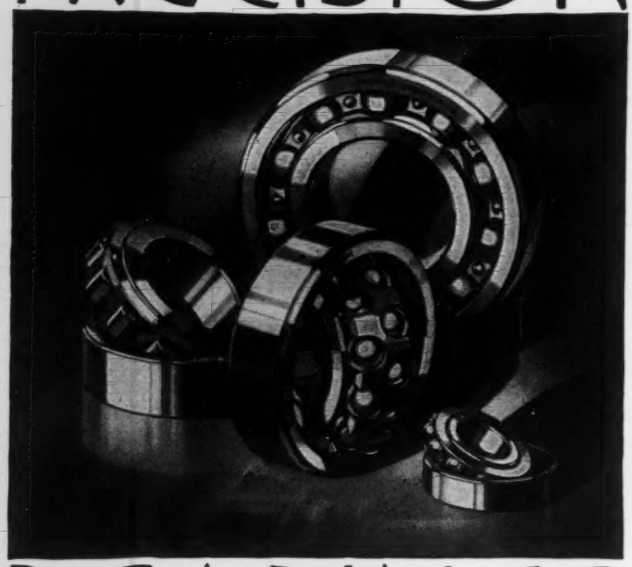

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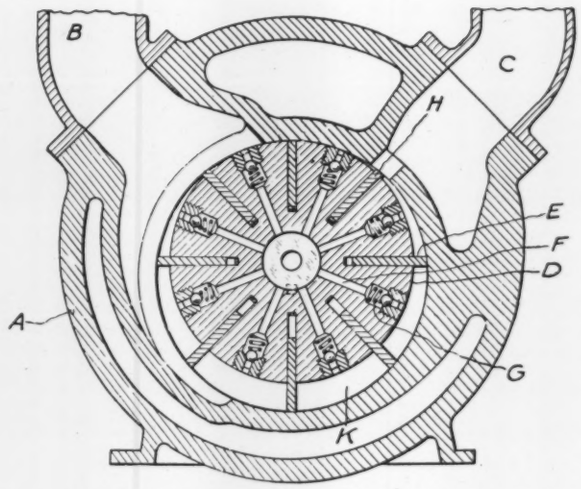

Fig. 2—Pressure relief during exhaust cycle of this vacuum pump improves power characteristics

between the rotor blades, extend from the periphery of the rotor inward to its bore, through which supplementary exhaust is effected. Their outer ports are counter-bored and threaded to accommodate spring ball valves *G*. When the rotor revolves, these valves normally are held closed by combined spring pressure together with centrifugal force.

The inventor describes the action thus: "With the rotor turning anticlockwise, the part of the crescent-shaped space *K* between each pair of vanes—after leaving the intake—constitutes a compression chamber from which most of the air is expelled as valve *G* opens. The air which remains after the pressure in the chamber has been lowered to the predetermined maximum is discharged through the outlet *C* at whatever final pumping pressure may exist.

"These compression chambers revolve with the rotor and the point at which exhaust begins varies as the work of evacuating proceeds. As the pressure at the intake drops, air within the pump will be compressed relatively higher and higher before the valves *G* open. Hence, though the compression ratio increases, the pump discharges a lessening mass of air and the difference in power needed at the start and after the start is not very great."

A PATENT covering a suction device for successively feeding individual sheets of paper from a stack or pile has been granted to Shala W. Henry of Jamaica Plain, Mass., and assigned to the Boston Envelope Co.

A side elevation of this device in partial section is shown in *Fig.* 3, together with the magazine trough *A* holding the stack of sheets. At the delivery end of the magazine is a rubber delivery bed *B*. For delivering sheets singly over the lip of this delivery bed there is

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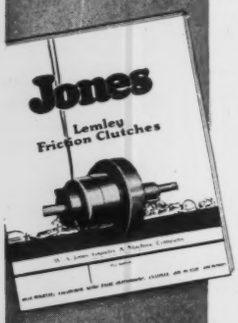

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FRICTION CLUTCHES AND TRANSMISSION APPLIANCES

provided rotary suction drum *C*, driven by shaft *D*. In the periphery of this drum are several evenly spaced suction pockets *E*.

The drum is supported so that its periphery is held in such close proximity to the delivery edge of rubber bed *B* as to allow space for passage of only one sheet at a time. The side of the drum fits closely against a circular valve disk. This remains stationary as the drum turns, being held in place by supporting arm *F* whose extension *G* partially encircles the valve disk. The disk is held to it by screws as shown. The disk at the same time is held in close contact with the side of the drum by coil springs, indicated by *M*, which are backed by a secondary disk or backing plate.

The suction pockets are provided with side ports *H* which open through the side of the drum and normally are closed by the valve disk, which in turn has a suction port *J* connected to a vacuum pump. The inner face of the valve disk has an arc-shaped groove *K* into the center of which the suction port opens. As the drum revolves, its suction ports *H* register with valve groove *K* during the lower portion of the revolution.

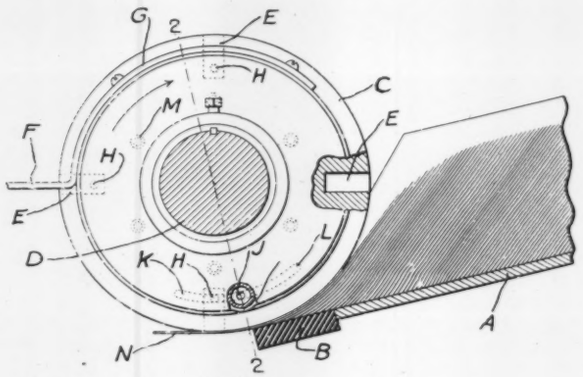

Fig. 3—Suction cylinder is employed to feed sheets one at a time from stack in a magazine

In operation the stack of sheets in the magazine is subjected to constant pressure toward the revolving drum, thus bringing the end sheet into contact with the drum. As soon as one of the suction pockets *E* reaches the point where its port *H* begins to register with valve groove *K*, as it does after passing point *L*, the resulting vacuum created in the pocket grips the end sheet to the periphery of the drum and feeds it out over the lip of the rubber bed. Sheet *N* in the illustration is in the process of being fed out in this manner and will be followed in succession by those behind it as the other suction pockets come into action. In the meantime, they are held back by their contact with rubber bed *B*, which prevents the ejected sheet from dragging along with it the one adjacent to it.

This patent is designated as No. 2,058,979.

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Handbook of Engineering Fundamentals

Edited by Ovid W. Eshbach; published by John Wiley & Son, New York; available through MACHINE DESIGN *for* $5.00 *plus* 15 *cents postage.*

This is a new engineer's handbook which, though complete in itself, is the first of a series designed to cover the engineering field in a manner different from previous conceptions. This first volume is designed to present a complete summary of facts underlying engineering practice and since mathematics, physics and chemistry form the basis of all engineering, these are the fields dealt with in it.

The first section is devoted to mathematical and physical tables, attention having been given to their arrangement and typography to attain maximum convenience. Other sections covered are: dimensional systems and theory of dimensional analyses; modern theory of fluid mechanics as applied to hydraulic and aerodynamic mechanisms; latest concepts in thermodynamics; and electrical and chemical fundamentals. Of particular interest to machine designers is the extensive treatise on properties of metallic and nonmetallic materials with reference to features of manufacture and use.

□ □ □

Steel Physical Properties Atlas

By Charles Newman Dawe; published by the American Society for Metals, Cleveland; available through MACHINE DESIGN *for* $2.50 *plus* 15 *cents postage.*

This book is a compilation of average and conservative physical property data for the most generally-used plain carbon and alloy steels and steel castings. Information of this type has been scattered, thus this complete and concise Atlas will be most useful to the engineer or metallurgist requiring ready information on physical properties of ferrous metals upon which to figure designs.

At a glance properties of various types of steels as affected by carbon content, alloy content and heat treatment, as well as other influencing factors, can be ascertained. The author employs a unique method to present the data. Thirty-five attractive full-page graphs, many of them in three colors, are used. The

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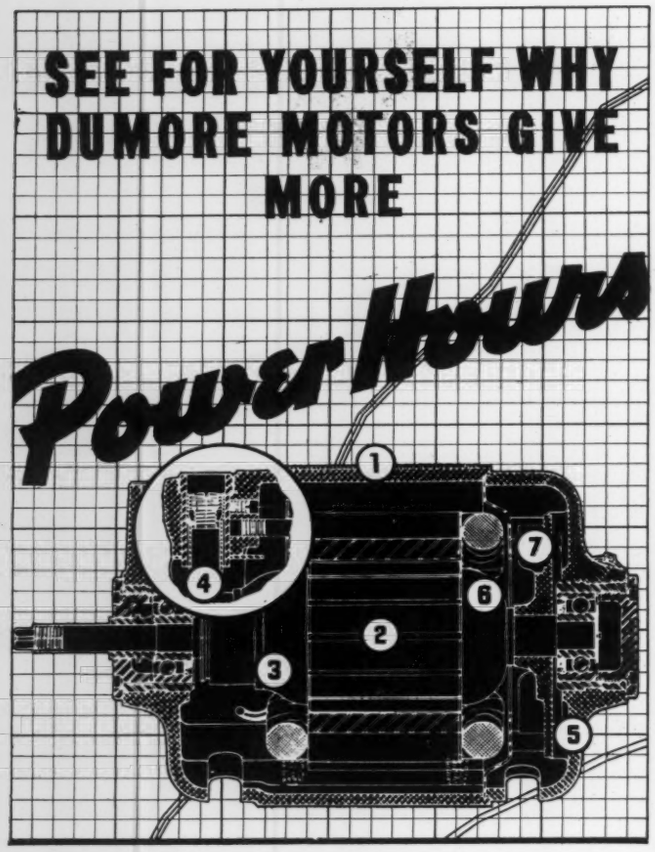

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Theory of Elastic Stability

By S. Timoshenko; published by the McGraw-Hill Book Co., New York; available through MACHINE DESIGN *for* $6.00 *plus* 15 *cents for postage.*

This is one of the Engineering Societies monographs, publication of which is being underwritten by the four national engineering societies in order to get vital basic technical information into the hands of the engineering profession.

In this book the author, who is professor of engineering mechanics at the University of Michigan, makes a thorough graphical and mathematical survey of a subject which is of special interest to mechanical engineers concerned with aircraft design. In aircraft design it must be kept in mind that sections of thin sheet material may prove unstable under the action of forces in their own planes, with resulting sidewise buckling. Thin cylindrical shells likewise may buckle under axial compression, bending, torsion or combinations thereof. Professor Timoshenko analyzes such cases exhaustively, pointing the way to safe design.

Superficial mathematics have no place in this book and a general brushing up on higher mathematics—especially calculus—is in order before it can be studied and used to advantage. In other words, it is not written for rule-of-thumb designers.

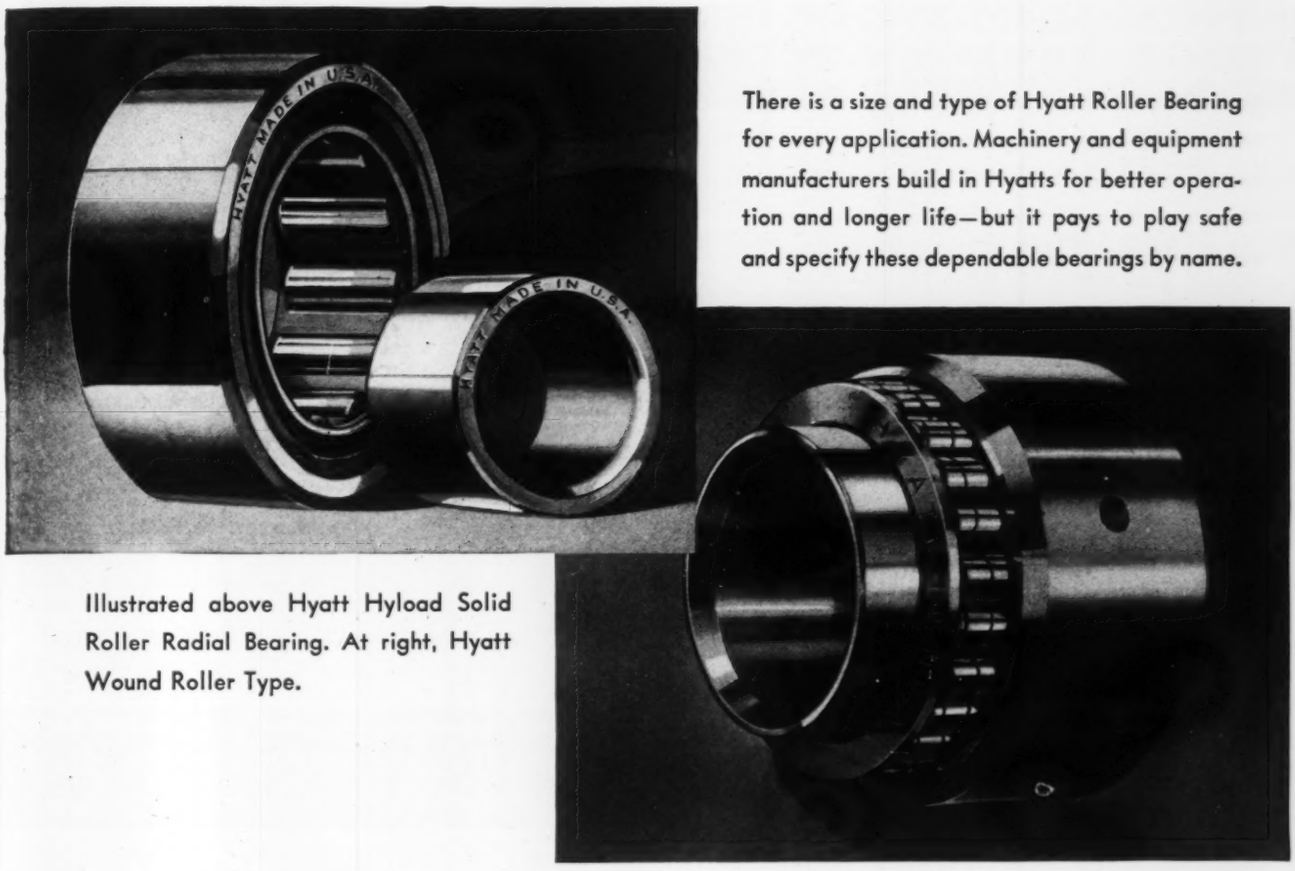
□ □ □

Materials of Engineering

By Herbert F. Moore; published by McGraw-Hill Book Co., New York; available through MACHINE DESIGN *for* $4.00 *plus* 15 *cents postage.*

In this fifth edition a chapter has been added on failure of materials by corrosion and wear. The chapter on failure by "creep" has been rewritten in line with recent test results. Significant additions have been made to the chapter on failure by fracture and considerable space is devoted to use of yield strength as a criterion of failure of elastic properties in a material.

Several changes have been made in the chapter on crystalline structure of metals. Material has been added on the properties of die-casting metals, on the properties of synthetic resins and other "plastics".



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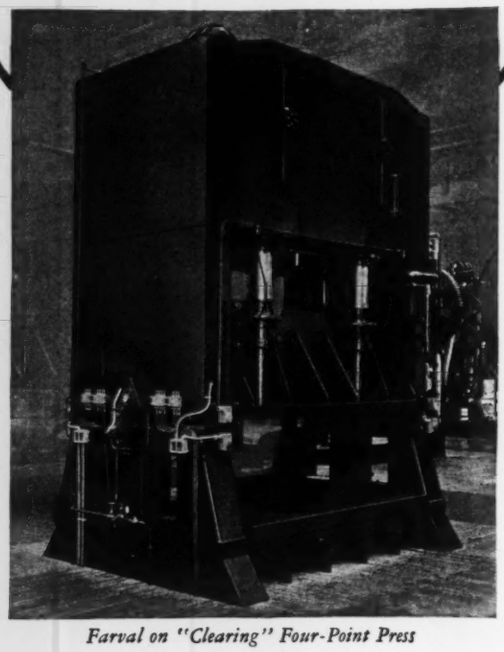

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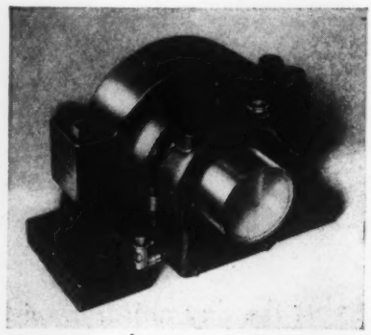
A SPECIAL roller-bearing pillow block for service involving heavy end thrust in addition to the radial load is now being produced by Fafnir Bearing Co., New Britain, Conn. In the new pillow block, a separate heavy-duty ball bearing to take the thrust loads is included as an integral part of the assembly. The design is said to be definitely superior in capacity and service life to that in which bronze plate thrust carriers are used.

Arrangement of the bearings is such that the entire radial load is taken by the roller bearing, while all the forces tending to displace the shaft axially are borne by the ball bearing. A spherical housing construction which provides self-alignment, similar to that used in other Fafnir roller-bearing pillow blocks, is also a feature of the design. The housing is of the two part type, which simplifies assembly. It is oil tight and equipped with a leveling device for oil lubrication. The roller bearing itself is of the special type recently developed in which an increased number of solid rolls are incorporated, thus giving the greatest possible load capacity. The cage is also said to be of unusually sturdy construction. These pillow blocks are now available for shaft sizes ranging from 3 5/16 to 10 inches, and with radial load capacities up to 250 tons.



Built-in ball bearings take thrust load in new pillow block

Reduces Length of Coupling

OVERALL length of the unit is reduced by one-third in the new flange-body design flexible coupling introduced by Lovejoy Tool Works, 5018 West Lake

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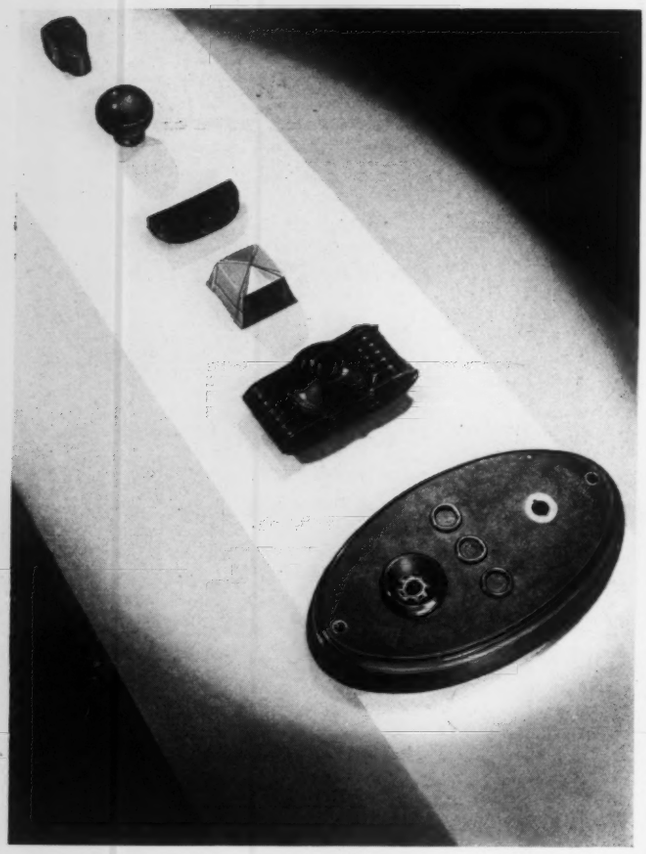


60 years
OF ACCUMULATED SKILL

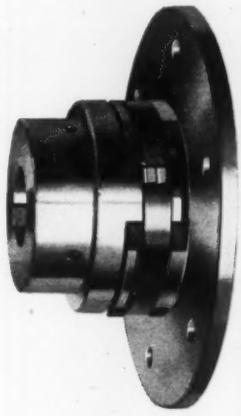
Sixty years of Plastic Molding Experience—places Auburn Button Works definitely to the front as pioneer plastic molders. In this period of time Auburn has accumulated a vast fund of experience that saves you in numberless ways but costs you not one penny—Years of turning blue prints into entirely new products and at the closest of tolerances is an aid to your design problem that must be used to be fully appreciated—On your next molded plastic problem—Specify Auburn.

Established 1876

MOLDED PLASTICS DIVISION OF
AUBURN BUTTON WORKS, Inc.
AUBURN, N.Y.

street, Chicago. This type WF coupling, shown herewith, is made with one of the bodies in the form of a flange which bolts on to the flywheel or to a clutch or brake drum. A recently installed coupling of this type capable of carrying a load of 324,000 inch pounds extends less than 6 inches beyond the rim of the flywheel. The unit will be made in sizes from 3 to 14 inches bores suitable for 2500 horsepower and 100 RPM.

In the design free floating load cushions are held in place by a quickly removable outside retaining spring. Load cushions can be removed and replaced in a few minutes without tearing down the coupling. Three types of resilient cushioning materials are available for each of these couplings: Metalflex—a brake lining material used for heavy shock loads as in excavating machinery, steel mill equipment and other machines exposed to extreme weather conditions; leather load cushions—of oak tanned belting leather for use on sustained loads and greater misalignment; and multiflex cushions—a rubber duck fabric, vulcanized under high pressure, for use on fluctuating loads and where high resilience is required.



Heavy duty coupling is made for cramped quarters

Seals Bearing Against Dirt

ENTRANCE of dirt and the escape of lubricant which have lowered the efficiency of many bearings has been overcome in two new types of self-sealed precision ball bearings introduced by Norma-Hoffmann Bearings Corp., Stamford, Conn. These bearings—the 9000 D and the 9000 DD series—employ inwardly extending, close-fitted flange shields of advanced type which do not rotate or contact with rotating seal parts and are equally effective in retaining grease in a horizontal or vertical position.

A single side shield is used in the 9000 D series, shown at the left of the illustration, while two shields in the 9000 DD series insure that the bearings are totally sealed against the entrance of dirt or foreign matter during assembly, operation or disassembly. The metal seals clear the recess on the inner ring, obviating

Everyone Agrees on SHAKEPROOF

THE *Triple-Action* LOCK WASHER

NEW *TAPERED-TWISTED* TEETH PROVIDE AMAZING LOCKING POWER

WHEN connections are locked with Shakeproof they are positively protected against the damaging effects of vibration. Three vital mechanical forces function co-operatively to prevent the nut or screw from working loose. First, there's Strut-Action, produced by each tooth biting into both nut and work surfaces and setting up a powerful leverage against any backward movement of the nut. Second, is Spring-Tension, the force that, under vibration, keeps the teeth biting ever deeper and assures a permanently tight lock. And, third, there's Line-Bite at initial contact, which means that a substantial portion of each biting edge is effective immediately to form a really tight lock.

FREE TEST RING PROVES IT!

You can see for yourself how Shakeproof Lock Washers do deliver greater locking power. Our free test ring, holding an assortment of five different sizes in both External and Internal types, is yours for the asking. Get acquainted with Shakeproof's new tapered-twisted teeth now—write for your Free Test Ring today!

SHAKEPROOF LOCK WASHER CO.

Distributor of Shakeproof Products
Manufactured by Illinois Tool Works

2551 N. Keeler Ave., Chicago, Illinois

In Canada: Canada Illinois Tools, Ltd., Toronto, Ont.

Copr. 1936 Illinois Tool Works

U. S. Patent Nos. 1,862,486 1,909,476 1,909,477 1,419,564 1,782,387 1,604,122 1,963,800
Other Patents. Patents Pending. Foreign Patents.

THE DESIGNING ENGINEER *Says...*

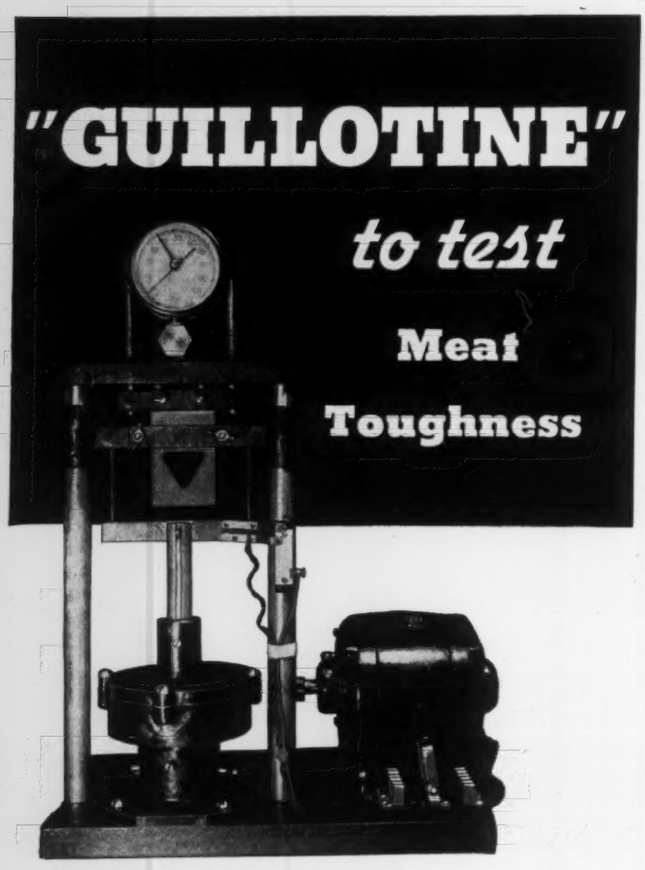
To insure the performance of any metal product all connections must be locked permanently tight. That's why I specify Shakeproof—I've tested its new tapered-twisted tooth principle and I'm convinced it's the one lock washer that never let's go!

THE PRODUCTION CHIEF *Says...*

On the production line we need a lock washer that's easy to handle, doesn't spread and locks tight with a minimum of time and effort. Shakeproof provides all these advantages and, what's more, we never have complaints on nuts or screws working loose during shipment.

THE PURCHASING AGENT *Says...*

I'm looking for uniform high quality, dependable performance and a reliable source of supply. Shakeproof meets these requirements fully and also knows how to co-operate with their customers so that orders are handled efficiently.

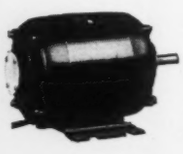


. . . uses a

BODINE MOTOR

Human judgment could not reliably gauge the juiciness and tenderness of meat. Hence, Alice M. Child, Associate Professor of Home Economics, University of Minnesota, has planned machines to accurately measure these properties. These machines are powered by Bodine motors.

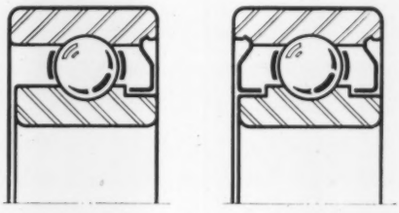
Bodine motors are meeting exacting requirements in many laboratories and in industry. The Bodine line includes all types of fractional horsepower motors. For over 30 years, Bodine engineers have specialized in adapting these motors to individual jobs. They can help solve your motor problems. Write Bodine Electric Co., 2258 W. Ohio St., Chicago, Ill.



BODINE
FRACTIONAL H. P.
MOTORS
ENGINEERED FOR YOUR PRODUCT

the possibility of drag or frictional resistance. Consequently there is no power loss which means higher speeds and increased efficiency in certain types of units. The shields occupy less space within the bearing than

Flanged shields serve as efficient seal for bearing



the standard felt seal and the 9000 series has a greater grease capacity providing sufficient lubricant for long continuous service. The bearings are available in a full range of sizes and are interchangeable with single felt seal bearings of the wide outer ring type from 6 mm. to 26 mm. in bore.

Shockproof Plastic Is Developed

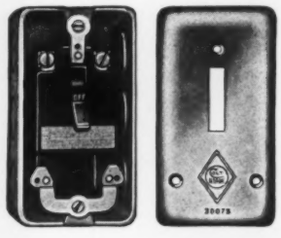
THREE times the resistance to shock of ordinary plastics is claimed for a new molding material developed by General Plastics Inc., North Tonawanda, N. Y. It is especially designed for heavy duty parts and is suitable for use in machines or other applications where resistance to shock is encountered.

The new material which has a weight of 22.4 grams per cubic inch is called 1547 Black and has an impact strength of .5 ASTM. Properties of the plastic permit machining and sanding of the molding, and subsequent buffing back to its normal luster without exposing filler spots or impairing the normal qualities of the material. It is preformed with hand equipment only.

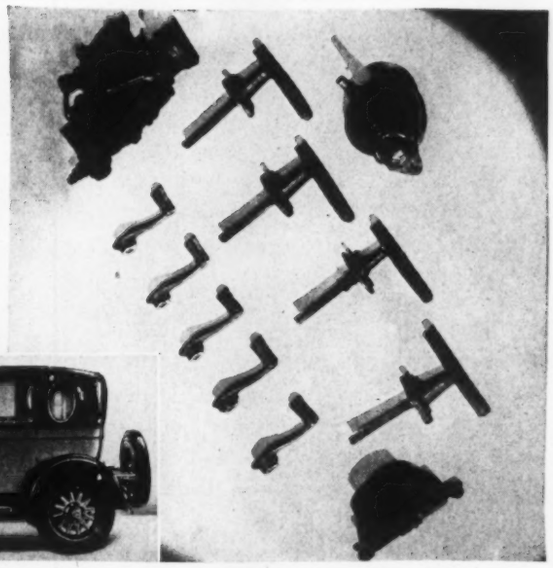
Compact Circuit Breaker Is Offered

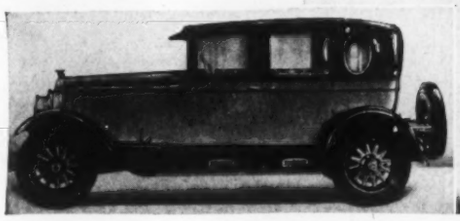
Made to fit standard mountings, a compact auxiliary circuit breaker has been brought out by Colt's Patent Fire Arms Mfg. Co., of Hartford, Conn. It is known

Yoke mounted type circuit breaker made for many industrial applications



as the "yoke mounted" Protectit and is designed to be mounted in standard wall boxes as well as in special metal cabinets for surface mounting. Two types are



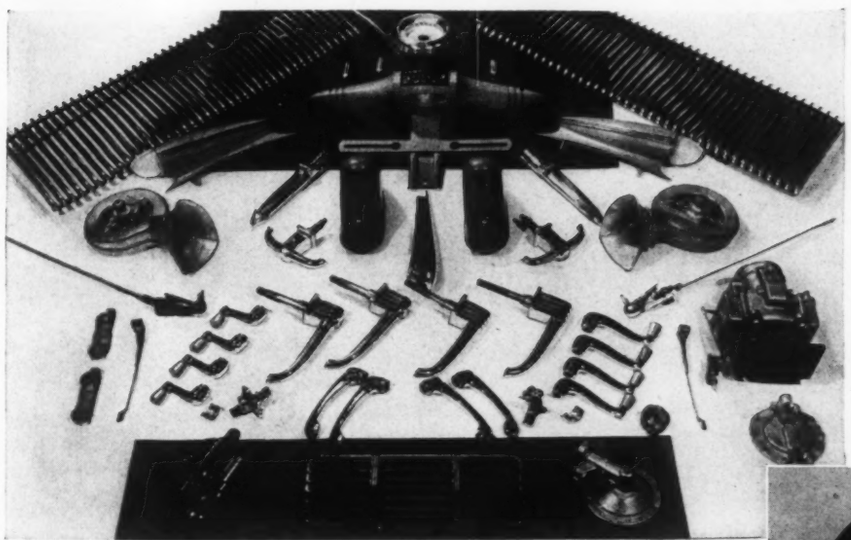


1927

12 ZINC ALLOY DIE CASTINGS

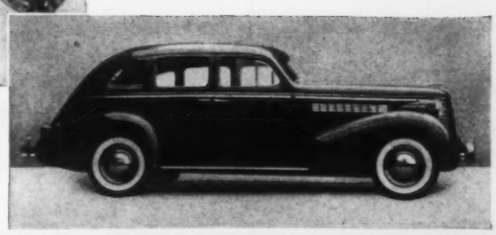
10 YEARS OF PROGRESS

An increase from 12 to 50 ZINC Alloy Die Castings carried on Buick cars—a contribution to the low cost and smart appearance of today's automobiles.



1937

50 ZINC ALLOY DIE CASTINGS

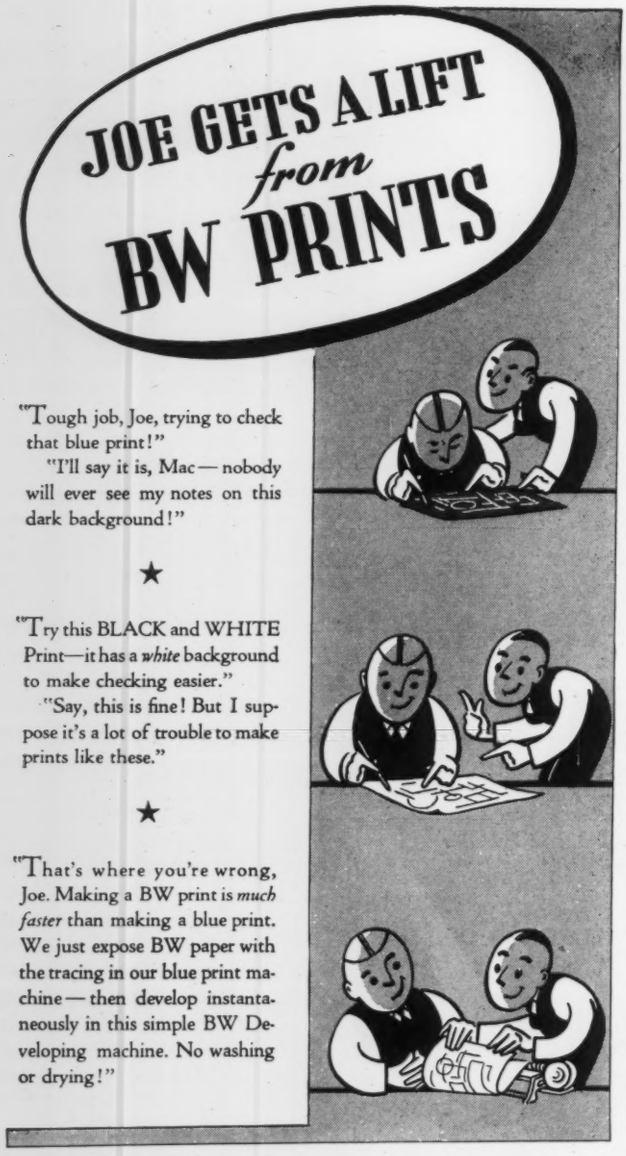


The Research was done and the Alloys were developed with

HORSE HEAD SPECIAL

(99.99+% UNIFORM QUALITY) ZINC

THE NEW JERSEY ZINC COMPANY 160 FRONT ST. NEW YORK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"I'll say it is, Mac — nobody will ever see my notes on this dark background!"
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★
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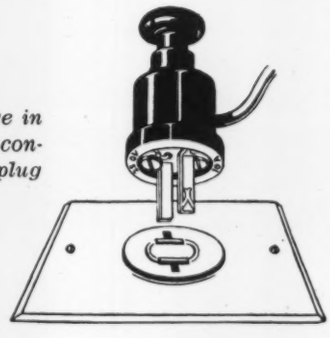
available, a fixed capacity device made in ten differently rated sizes, and the interchangeable heater element type for which there are 20 heater elements of different ratings. Both Protectits have a maximum voltage rating of 250 volts for either alternating or direct current and a maximum of one horsepower rating.

Wedges Lock Plug in Socket

PRONGS that wedge and lock to the socket are an integral part of the unique electrical plug, designed for applications where the cord is likely to be pulled from its socket inadvertently, being manufactured by Hy-Duty Products Co., 1803 South Hope street, Los Angeles. This plug, shown herewith, has a novel rubber ram which is pushed inward by hand, causing an auxiliary bayonet wedge to slide along each of the two contact prongs into the receiving socket. These



Auxiliary bayonet wedge in plug slides along the contact prongs to lock the plug in the socket

wedges insure a positive contact and prevent the plug from being pulled from the socket until the ram is first pulled out, relieving the pressure. Even if the socket is worn and loose the plug will grip firmly, but it can be instantly released when desired.

Coupling Is Simple and Compact

AN IMPROVED flexible coupling embodying compact design, ruggedness and simplicity of construction has been brought out by Whitney Chain & Mfg. Co., Hartford, Conn. It is of the single chain design which allows the shearing stresses to be taken by the combined cross section of the chain pin, bushing and roll, insuring maximum strength. Maximum chain roll and sprocket tooth area is made certain with the special wide chain design used in the coupling.

A cast aluminum, smooth surfaced cover is provided with the coupling and adds to the safety as well as the appearance of the equipment on which it is used. Lugs on the inside of each half of the cover grip the chain roll and give a positive cover drive with balanced construction. The coupling and cover can be

ROLLING SELF-ALIGNMENT

and generous radial-thrust capacity are inherent features of the exclusive Shafer Concave Roller design. Reserve capacity assures dependable performance even under severe operating conditions, for the bearing action is unchanged by misalignment, shaft deflection and shock loads.

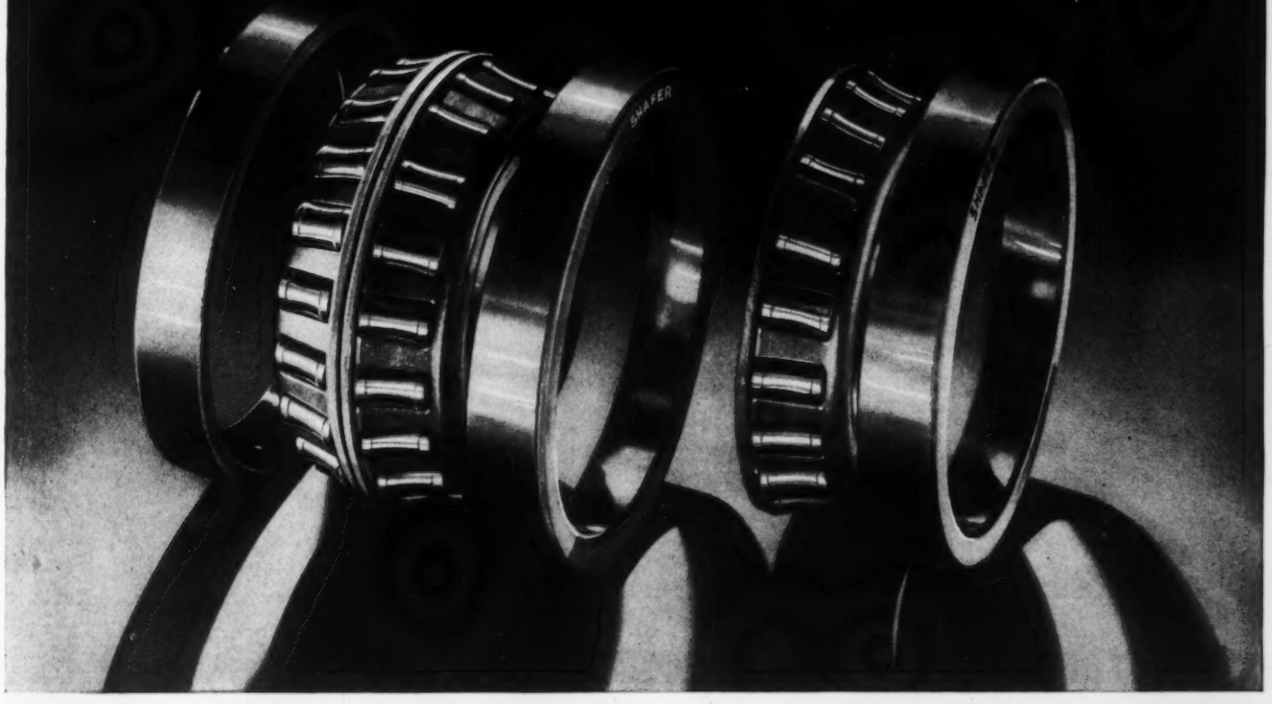
Shafer Bearing Corporation, 35 East Wacker Drive, Chicago

SHAFER

PILLOW BLOCKS • FLANGE UNITS • TAKEUP UNITS

HANGER BOXES • CARTRIDGE UNITS • DUPLEX UNITS

CONVEYOR ROLLS • RADIAL-THRUST ROLLER BEARINGS



EVERYTHING YOU NEED IN A ROLLER BEARING

YOU'RE LOOKING FOR A BETTER OIL SEAL?

THE *Garlock* KLOZURE

YOU won't need to look far, if you're looking for a better oil seal. Just phone the GARLOCK representative and he will tell you why thousands of users have found the GARLOCK KLOZURE a *superior* oil seal. The KLOZURE sealing ring is a special GARLOCK compound—dense, grainless, tough. It *resists* oil and water at high and low temperatures . . . does not become soft and flabby. GARLOCK KLOZURES are made in a complete range of sizes and for every type of oil seal application.

Write for booklet

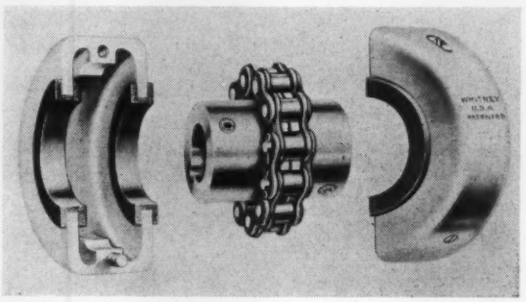
THE GARLOCK PACKING CO.
Palmyra, New York

In Canada: The Garlock Packing Company of Canada, Limited, Montreal, Que.

GARLOCK

disconnected without disturbing shafts or bearings.

Other features of the coupling which will prove attractive to machine users are the easy installation of the unit, allowance for motor end float and slight shaft misalignment, and its clean appearance. The

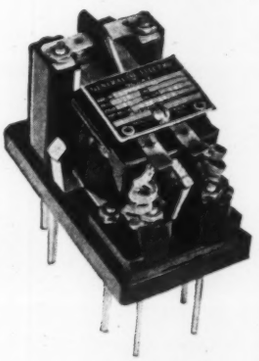


Lubricant is sealed in by cover of improved coupling

cover is made with attached leather grease retaining washers and the two halves are connected with machine screws and lock washers for strength and safety. The couplings are furnished in a wide range of sizes with capacities ranging from one to several hundred horsepower.

Multi-Use Relay Offered

A NEW auxiliary relay, the HGA, compactly designed with base and cover of black molded compound, that can both open and close a circuit and operates on either alternating or direct current has been announced by the General Electric Co., Schen-



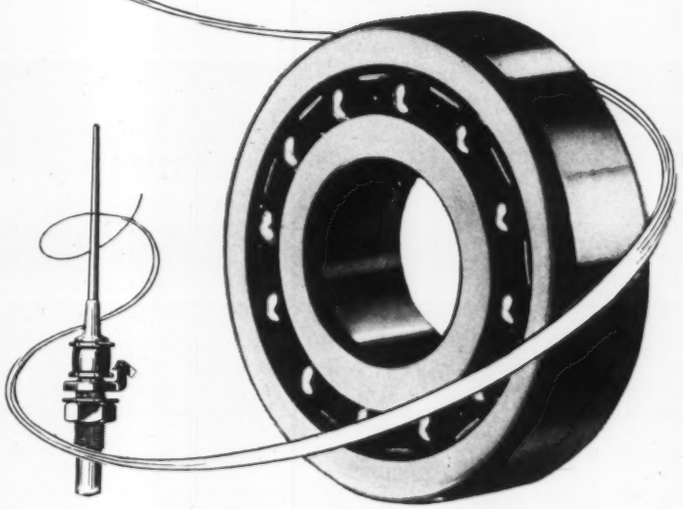
Relay operates on either direct or alternating current

ectady, N. Y. The new relay is made in double pole arrangement with either two or four contacts and can be furnished with the operating coil for one to five amperes, direct current, and six to 250 volts, direct current; or 115 to 575 volts, alternating current.

Stationary contacts are silver tipped, and are doweled

Another Industry Salutes SKF *Quality...*

3749



More than 6,000,000 SKF Roller Bearing Bolsters are used in spindles throughout the world.

Famous SKF Self-Aligning Ball Bearing. The Textile Industry was first to use this bearing.

When Industry awoke to the sky-high cost of inefficient bearings, it naturally looked for help from the largest maker of industrial bearings in the world...SKF. And Industry received that help.

SKF makes it a habit to produce the right bearing for every purpose...makes it another habit to put the right bearing in the right place...always.

In the Textile Industry, the leading manufacturers select SKF Bearings. Plant after plant uses them exclusively. For makers of textiles were among the first to realize that they cut down shut-downs . . . lop off top-heavy overhead . . . wipe out waste.

Follow the example of the Textile Industry. Select your bearings on performance, too. Switch or stick to SKF. . . . SKF Industries, Inc., Front Street and Erie Avenue, Philadelphia, Pa.

Unbreakable Body.

Oil feed adjustment with shut-off switch.

Sight glass in shank to adjust oil feed to proper volume.

Self-closing hinge cover for easy filling.

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They Take Up Their Own Wear
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Air from cylinder through by-pass in cylinder head enters this slot on its way to the outlet above. No opening in curved inner surface of cylinder means quiet operation.
OUTLET threaded for iron pipe.
Enclosed stud in piston holds wing close to cylinder at top, preventing loss of air pressure or vacuum.
Air coming in at inlet at side comes through this slot into cylinder head by-pass and thence into the cylinder. No opening in curved inner surface of cylinder means quiet operation.
INLET threaded for standard iron pipe.
No composition tips to require renewal frequently.
Wing kept in constant contact with cylinder by centrifugal force.
Wing and cylinder surface become hard and glassy-like, insuring a perfect fit and positive pressure or vacuum.
Big air space resulting from small piston and curved wings.
The easy-action hinge enables wing to open and close, thus becoming wear-compensating by the action of centrifugal force.

A DUST COLLECTOR for Your Surface Grinder

A powerful apparatus for keeping fine grinding dust away from your work and from your own lungs.

It's a Great Protection Against Lung Dust Diseases

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Machine Design Can Be Greatly Helped
by using air movement instead of mechanical devices. Consult with our experienced engineers about air pumps and their uses

LEIMAN BROS. PATENTED
Rotary Air Pumps
are standard equipment on many automatic machines.

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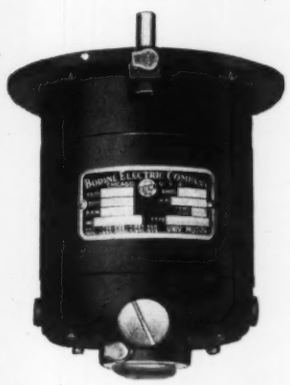
LEIMAN BROS. New York Corp., 23 Walker St.
Makers of Good Machinery for 50 Years.

to the base to assure positive line-up with the moving contacts, while the latter, also silver tipped, are mounted on a molded carrier attached to the armature. The contacts will make and carry 30 amperes for one minute or 12 amperes continuously. Parts in the magnetic circuit are of silicon steel, cadmium plated. In addition to the low residual provided by the silicon steel, an air gap is introduced in the magnetic circuit by a small nonmagnetic shim to prevent sticking of the armature on residual magnetism.

Develops Mounting for Small Motors

Small electric motors manufactured by the Bodine Electric Co., of Chicago, can now be supplied with flange mountings which permit the motors to be mounted either horizontally or vertically with the armature shaft perpendicular to the mounting surface. The flange mounting is adaptable to either ball or sleeve bearing motors. A groove machined to close tolerances is provided on the face of the flange insuring accurate location and a tight fit. The type N-1 frame with which the new mounting is used is normally rated at 1/50 horsepower, but lower ratings can also be furnished. The new mounting can be provided either solidly enclosed or with ventilating holes as desired.



Flange mountings permit motor shaft to run at a right angle to mounting surface

---

New Mountings Reduce Vibration

DESIGNED to deaden vibration, absorb shock and reduce noise, a new line of rubber to metal mountings for mechanical equipment has been developed by the B. F. Goodrich Co., Akron. Known as Vibro-Insulators the mountings are made so that the rubber carries loads in shear rather than compression giving eight times the sensitivity to movement, it is claimed. The rubber, of the highly oil-resisting variety, is attached to the metal plates with a brass plating type of bond which gives an adhesion of 200 pounds per

MACHINE DESIGN
MACHINE DESIGN
MACHINE DESIGN
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CONTENTS . . .
Data Sheet No. 1 – General Information
Data Sheet No. 2 – Editorial Information
Data Sheet No. 3 – Circulation Information
Data Sheet No. 4 – Advertising and Mechanical Information

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for these

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Cleveland, Ohio

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. . . . Reduce Costs

IDEAL SOLDERLESS-TAPELESS WIRE CONNECTORS

Used by leading manufacturers of electrical appliances because they reduce material costs, reduce application time and labor.

You merely

A—Skin wires as usual

B—Screw connector onto wire

C—Job is finished; time, 15 seconds!

No special tools needed . . . . no solder . . . . no soldering irons . . . . no tape. Samples upon request.

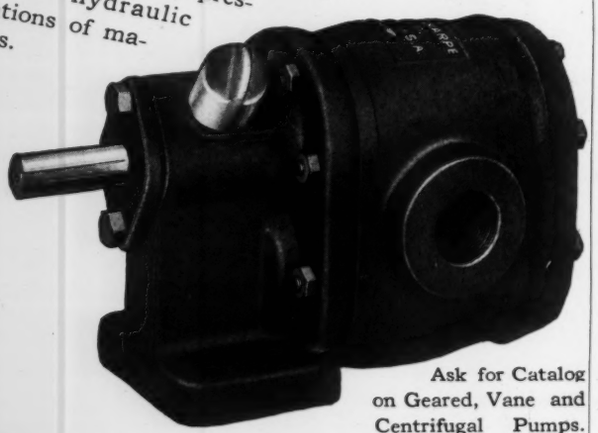
Fully approved. Listed by Underwriters' Laboratories.

IDEAL COMMUTATOR DRESSER COMPANY

1059 Park Avenue Sycamore, Illinois

Use Nos. 53 and 55
for Large Volumes
---High Pressures

Helical Gears and Ball Bearings insure quietness and dependability in supplying oil under pressure for hydraulic operations of machines.



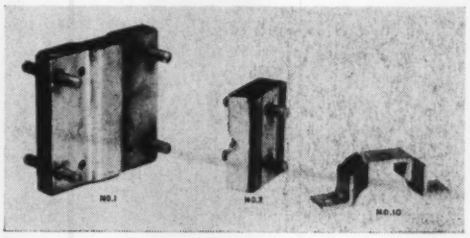
Ask for Catalog on Geared, Vane and Centrifugal Pumps.

Brown & Sharpe Mfg. Co.
Providence, R. I.

BROWN & SHARPE PUMPS
B·S

square inch.

Three types of mountings are stocked by the company. Type No. 1 as seen in the illustration is said to have a maximum load capacity of 800 pounds and



Mountings with rubber in shear are available in three types

a minimum frequency of 800 vibrations per minute. No. 2 will support a load of 200 pounds and has a minimum frequency of 1200 vibrations per minute, while type No. 10, which is of the double shear type is available in sizes for loads from 50 to 3000 pounds and has a minimum frequency of 1000 vibrations per minute.

Coated Electrodes Are Improved

HEAVY coated electrodes for arc welding in a new design have been announced by Metal & Thermit Corp., 120 Broadway, New York. The new electrode, known as Murex type N, is designed for bridging gaps where fit-up between plates is poor and, in the smaller sizes, may be used on vertical and overhead work or to make rapid, single pass welds on light gage materials. The physical properties of the metal deposited by the electrode are said to range from 74,000 to 84,000 pounds per square inch in tensile strength with 26 to 24 per cent ductility.

Weld Strength Increased

TENSILE strengths of 100,000 pounds per square inch have been successfully tested in welds made with the "Shield-Arc 100" electrode announced recently by the Lincoln Electric Co., Cleveland. The new electrode is heavily coated of the shielded arc type and is designed for welding steels having higher ultimate strengths than those welded with Lincoln "Shield-Arc 5" electrodes.

Welds produced by the new electrode in the higher tensile steels possess ultimate strength of 100,000 to 105,000 pounds per square inch as welded. Ductility of the welds is from 12 to 18 per cent elongation in 2 inches.

When stress is relieved, the company claims, welds in mild steel plate will possess an ultimate strength

The Aristocrat of Bearings

The Season's Greetings to All and grateful thanks to our many customers who have passed along the good words in behalf of *The Aristocrat of Bearings.*

HOOVER BALL AND BEARING COMPANY

ANN ARBOR • MICHIGAN

THE SOLID SHIM
THAT P-E-E-L-S
FOR ADJUSTMENT
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cutting tools
FOR PRECISION ADJUSTMENT of cutting tools, just P-E-E-L the paper-thin brass laminations . . . .002" or more at a time! No filing . . . no machining.
Setups can be made up from standard tool-holders without costly machining and fitting. A real money-saver. Tool-holders remain standard for retooling. Write for a sample of LAMINUM.
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LAMINUM
Precision adjustment SHIMS

OPEN TYPE

DESIGNED TO WITHSTAND

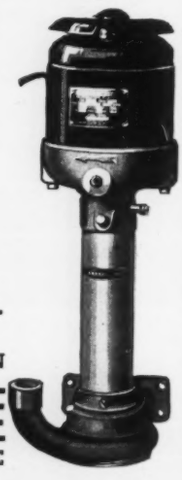
the destructive action of lapping compound when attached to grinding machines.

THE **BROWNIE Coolant Pump**

proves itself economically suited to any machine design.

Centrifugal in operation — the Brownie Pump is self aligning. Full rigidity of driving shaft is assured by the vital support of a ball bearing within one inch of the impeller.

Both drive shaft and impeller tube are one unit revolving together. There are no packings to leak and no screens to clog. Capacities 10-100 G.P.M.



TOMKINS-JOHNSON CO.
618 N. MECHANIC ST.
JACKSON MICHIGAN

CLOSED TYPE

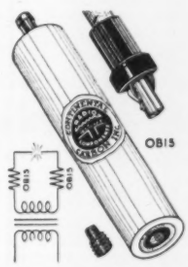
of 110,000 to 115,000 pounds per square inch, yield point of 95,000 to 105,000 pounds per square inch and ductility of 18 to 22 per cent elongation in 2 inches.

The new electrode is suitable for flat, vertical and overhead welding and is available in ⅛, 5/32 and 3/16 inch sizes.

Radio Interference Overcome

INTERFERENCE in radio reception from oil burner ignition systems can be overcome by an ignition interference suppressor brought out recently by Continental Carbon Inc., 13,900 Lorain avenue, Cleveland. The new device makes use of an Isolantite insulated tube and is intended for use in series with each high tension lead of an oil burner's ignition system.

The suppressor has a resistance of 15,000 ohms and successfully damps transient radio frequency oscillations in the high tension circuit, effectively reducing radio interference. A solderless cable terminal is provided at one end of the body which is 3½ inches long and 13/16 inch in diameter. A universal type threaded stud and double threaded brass insert in the suppressor permit convenient connection to practically all standard ignition transformers. Two of the devices are required for most oil burners.



Suppressor is easily installed on oil burner ignition systems

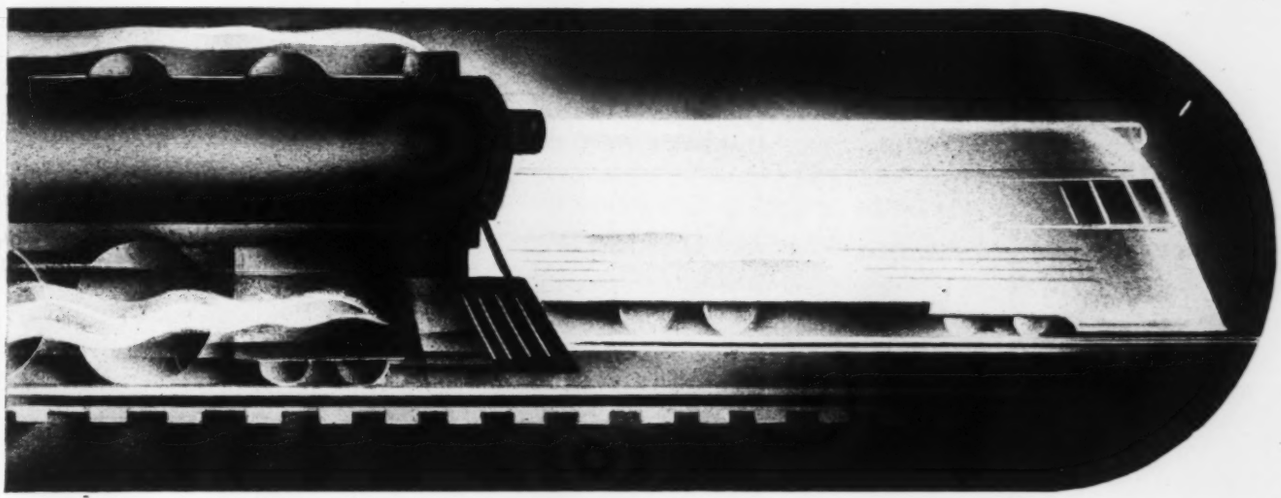
Color Service Initiated

So that a manufacturer will not go awry and paint his machine or product in discordant hues decreasing its appearance value, Sherwin Williams Co. has formed an Industrial and Transportation Color Service which places a staff of color specialists at the command of the prospective paint user. Assistance is not only given in developing desired colors and combinations for "dressing up" new or old equipment, but information on all types of finishes and their suitability for specific requirements is passed on.

When the color scheme has been worked out, panels and paint-out tests are made on the material to be finished. The department has cooperated with industrial designers and manufacturers on such jobs as the New Haven Streamlined Comet, the New York Central Mercury, Pennsylvania ferryboats, vacuum cleaners and a long list of automotive and transportation companies.

THE BULLDOG...

BECOMES A GREYHOUND



...BUT THE GREYHOUND'S JUST AS TOUGH!

On fast runs the lumbering locomotive gives way to lithe streamlined engines that cover the distance in far less time...Improved design contributes something to this speeding up of transportation, but far more important is the elimination of useless weight...Through the use of modern alloys possessing toughness combined with a high strength-weight ratio, rolling stock of every type is being made lighter without reduction in the factor of safety...Among the chief contributors to these improvements are the Nickel Alloy Steels, of which stainless steel is a popular type. For through a partnership with Nickel these steels are rendered tougher and stronger than the simple steels — more highly resistant to shock, stress, fatigue, corrosion, abrasion and wear. Perhaps you have a particular job (not necessarily connected with transportation) where the elimination of useless weight will effect worthwhile savings in operating and upkeep costs. We invite consultation. Nickel Alloy Steels, Nickel Cast Irons, or other alloys containing Nickel may be the answer.

NICKEL ALLOY STEELS

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N.Y.

SPEED REDUCERS

Motorized vertical helical reducer 4143-MV

Motorized double worm gear variable speed reducer 7-28-D

the above are among the many installations made by the Foote Gear Works Inc., and now doing service satisfactorily in plants throughout the country.

The vertical helical is one of 32 units installed to drive agitators in 126 foot diameter digester tank ½ H.P. motor—1200 RPM—ratio 80½ to 1. Installation made in southwest sewage disposal plant, Chicago Sanitary District.

123 page data book FREE

send for your copy to

FOOTE GEAR WORKS, INC.

Cut Gears Of All Kinds.

1301-G. S. Cicero Av., Cicero, Ill.

RACINE

Variable Volume Hydraulic Pump

A thoroughly proven, efficient pump for power transmission.

Capacities—
0 to 2000
0 to 4000
0 to 6000
cu. in. per min.

The variable volume feature eliminates bypassing of surplus oil, decreases heating and reduces horse-power requirements. Rated for pressures up to 1000 pounds per square inch.

Successfully applied and proven highly satisfactory on such applications as:

Presses
Die Casting Machines
Welding Machines
Chucking Operations
Machine Tools
Table Movements
Stokers
Conveyors
Broaching Machines
Bending and Rolling Equipment, etc.

A variety of valves and controls are available for standard operations

RACINE TOOL & MACHINE CO.

1773 State St. Racine, Wis.

MEETINGS *and* EXPOSITIONS

THE eyes of the engineering world or at least that part of it concerned with new ideas are turned towards the annual Leipzig Engineering fair in Germany, February 29 to March 8. The Leipzig fair this year will cover a wide area and will have 24 exhibition palaces of the Samples fair in the inner city. Over 5000 machines incorporating new design and concepts will be demonstrated in operation. The fair is the greatest of its kind held anywhere in the world and those who have the opportunity should make every effort to visit it.

Jan. 11-14—

National Association of Coin Operated Machine Manufacturers. Coin machine show to be held at Hotel Sherman, Chicago. Information regarding the show may be obtained from the association at 120 South La Salle street, Chicago.

Jan. 11-15—

Society of Automotive Engineers. Annual meeting to be held at Book-Cadillac hotel, Detroit. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

Jan. 11-15—

American Road Builders' association. Thirty-fourth annual convention and highway exhibit to be held at Municipal auditorium, New Orleans. Charles M. Upham, 952 National Press building, Washington, is secretary.

Jan. 25-27—

American Society of Heating and Ventilating Engineers. Annual meeting to be held at Hotel Statler, St. Louis. A. V. Hutchinson, 51 Madison avenue, New York, is secretary.

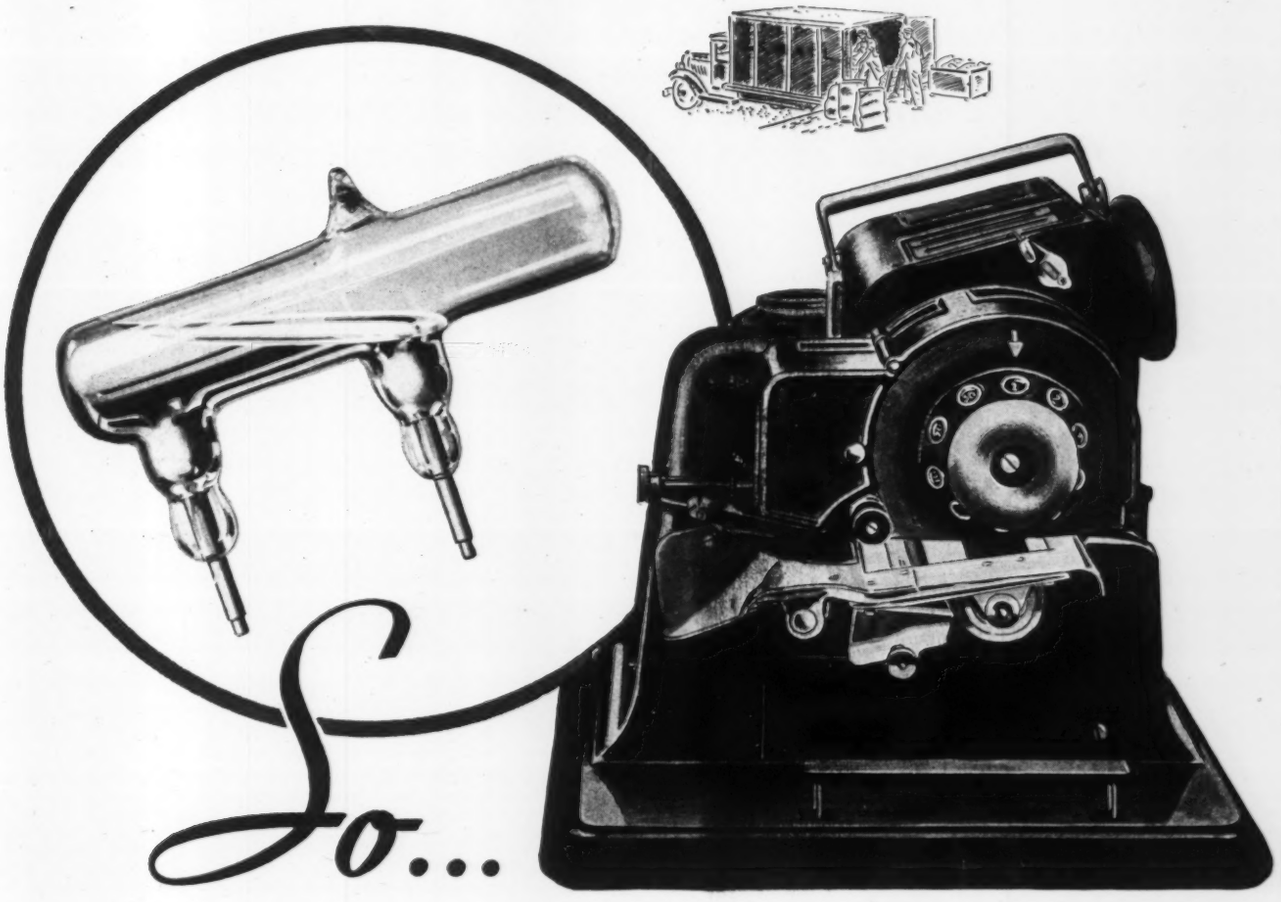
Jan. 25-29—

American Institute of Electrical Engineers. Annual winter convention to be held at Engineering Societies building, New York. H. H. Henline, 33 West Thirty-ninth street, New York, is secretary.

Feb. 14-19—

National Electrical Manufacturers association. Midwinter meeting to be held at Waldorf-Astoria hotel, New York. W. J. Donald, 155 East Forty-fourth street, New York, is managing director.

THE MAIL MUST NOT BE DELAYED . . .



KON-NEC-TOR SWITCHES WERE CHOSEN

A certain well-known manufacturer of postage metering machines formerly tried metal switches. Thousands of makes and breaks of the current would either cause the switches to become softened by heat and pitted or the toggle would break off from the heavy usage.

KON-NEC-TORS solved all his difficulties. The mercury contacts proved foolproof even after four straight years of service. No matter how fast the cancellations, the electric circuit broke clean and swift, due to the inherent snap-action of the mercury.

Use KON-NEC-TORS when you want dependable switching with no maintenance. They are ideally adapted to use where utmost reliability, quiet operation and long life are requisites, and their foolproof qualities make them ideal emergency switches.

For full details, address the General Electric Vapor Lamp Company, 825 Adams Street, Hoboken, New Jersey.

GENERAL ELECTRIC VAPOR LAMP COMPANY

761K

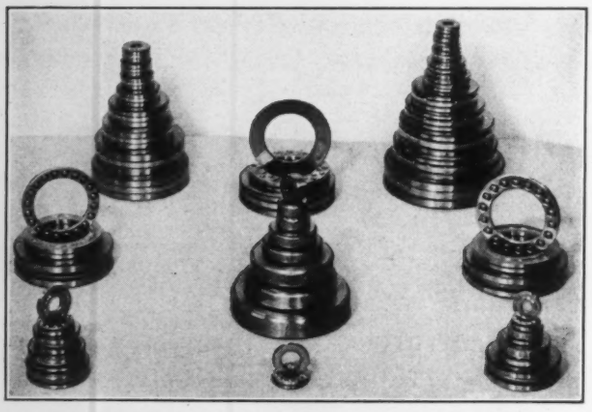
FOR THE
26TH TIME WE REPEAT

Our New Year's Resolution

"To make VIKING ROTARY PUMPS "still better" . . . in order that they may serve you "better still." . . . .

1911
1937

VIKING PUMP COMPANY
CEDAR FALLS, IOWA



SUCCESS OF YOUR PRODUCT
. . . . OUR PRINCIPAL CONCERN

The sincere interest of our organization in the successful operation of its customers mechanical developments is what has caused industry to more and more prefer Bantam Ball and Roller Bearings.

Of course, this interest had to be backed up by the ability to solve the bearing problem and in many cases do what others had not been able to accomplish. That, for instance, is why 95% of the automobiles built use Bantam Roller Bearings. Also why practically all Diesel Motors use them.

Every designing engineer in the country should have a copy of our new catalog. It shows a comprehensive picture of the bearings which are saving money for manufacturers of small and large machinery. Send TODAY!

THE BANTAM BALL BEARING CO.
SOUTH BEND, IND.

BBB TAKE YOUR TOUGHEST BEARING JOB TO BANTAM

MANUFACTURERS' PUBLICATIONS

ALLOYS (NICKEL)—Selection of metal as encountered by the engineer is described in a new booklet of International Nickel Co., 67 Wall street, New York city. This 48-page booklet, illustrated throughout, is primarily a guide-book to Monel and other nonferrous nickel alloys in the fields of engineering applications. Corrosion resistance and other properties of these metals are also covered, as well as the newer forms of the Monel metal, including types 'K," "S" and the like. Another section is devoted to nonmagnetic forms of the metal.

ALLOYS (STEEL)—In a recent bulletin, Union Drawn Steel Co., Massillon, O., covers its field service of men to assist steel users in choosing the right steel for each application and in developing production methods to obtain the desired results.

ALLOYS (STEEL)—Forming qualities, soldering practice, welding, cleaning and finishing operations of Paintgrip are presented in a folder recently announced by American Rolling Mill Co., Middletown, O. Paintgrip is a new galvanized sheet metal that is readily paintable without special acid treatments or weathering.

ALLOYS (STEEL)—Bulletin R-53, recently published by Manganese Steel Forge Co., Richmond street and Castor avenue, Philadelphia, will be of interest to those experiencing difficulties due to abrasion or breakage of parts. Tables of properties and applications are included in the bulletin.

BEARINGS—Principal dimensions for all single row, double row, radax and duplex bearings, extra large and small bearings, front and rear wheel bearings, magneto bearings, single and double N-D seal bearings and their variations, clutch throwout and conveyor bearings, and other ball bearings manufactured by the company, are listed in booklet A-178, recently issued by New Departure Mfg. Co., Bristol, Conn. List prices are also included.

CONTROLS (ELECTRICAL)—A release is being distributed by Hart Mfg. Co., Hartford, Conn., covering a slow break toggle switch for use on machines, heavy duty appliances, equipment using fractional horsepower motors, and special lighting circuits for use with alternating current only.

CONTROLS (ELECTRICAL)—A new remote control clutch release is described in Bulletin No. 127, recently

announced by Hilliard Corp., 102 West Fourth street, Elmira, N. Y. The release is an electromechanical latch mechanism connected to the yoke of a standard clutch by a suitable spring and lever arrangement.

COUPLINGS—A leaflet covering a three-jaw flexible coupling of special ball bearing type is being distributed by Boston Gear Works Inc., North Quincy, Mass. This coupling is equipped with an insert cage carrying hardened and ground balls, similar to those used in ball bearings, the balls contacting hardened and ground jaw surfaces to carry the load.

DRIVES—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., is distributing a new publication on types SH and DH speed reducers which covers single and double reduction units of the single helical gear type with antifriction bearings and splash lubrication for application in general industry and mining operations. Construction, design, efficiency and ratings of these gear units are described in the bulletin, as well as available speed ratios and methods for selecting the proper reducer and horsepower ratings.

DRIVES—Baldwin-Duckworth Chain Corp., Springfield, Mass., has recently issued a catalog "Chains and Sprockets for Power Transmission, Conveying, Elevating." Descriptions and illustrations as well as tables of dimensions, strengths and weights of various types of roller chains, cable or leaf chains, block chains, twin roller chains and numerous other special chains are discussed. Characteristics and specifications of sprockets and couplings are given. This catalog also contains an engineering section devoted to selection of the proper drive.

DRIVES—In a book profusely illustrated, with many tables, charts and drawings, Link Belt Co., 307 North Michigan avenue, Chicago, presents detailed information on the silent chain drive, the book being known as Data Book 125 (1936 edition). Some of the important data given in this book are: Information for the selection of silent chain drives; recommended selection for drives up to 2000 horsepower; lubrication and silent chain drive casings; dimensions of chains, wheels, wheel rims, hub sizes, bores, keys, etc.; drive accessories; and other miscellaneous information. The company's line of positive drives is also discussed.

FASTENINGS—Complete information on socket set and socket head cap screws, as approved by American Standards association, has been published in a data sheet by Bristol Co., Waterbury, Conn. Included also are data on socket head stripper bolts and pipe plugs.

FORGING—In a recently published folder, Kropp Forge Co., 5301 West Roosevelt road, Chicago, has published information describing and illustrating the company's facilities for making drop forgings and die blocks, as well as for heat treating and machining. Illustra-

WRIST WATCH or LOCOMOTIVE

It's Still a Machine!

Machines have become so interwoven into our economic and social pattern that their identity as machines often is lost. When the word "machine" is mentioned some individuals form a mental picture of a machine tool or other large unit. This impression is entirely too limited in scope, the field of machines ranging from the tiniest wrist watch to the largest locomotive. MACHINE DESIGN likewise is all-inclusive, covering every size and type produced.

Mechanical design knows no boundaries. Whether the unit is large or small, the same procedure must be carried out in the evolution of an idea. For that reason the designer of one type of machine often can find a solution to his particular problems in the accomplishments of design engineers in other fields.

MACHINE DESIGN serves as a clearing house for those ideas that will assist engineers in meeting the mechanical requirements of modern civilization.

tions also show numerous drop forgings indicating the wide range of forgings the company is capable of producing.

HEATING UNITS—Harold E. Trent Co., 618 North Fifty-fourth street, Philadelphia, is distributing a leaflet on electric heating cartridge units, and tubular heating units.

INSTRUMENTS—Brown Instrument Co., Philadelphia, is distributing catalog No. 6703 covering thermometers and pressure gages, and hygrometers for indicating, recording and controlling humidity and temperatures. The catalog is profusely illustrated, showing applications of these instruments in various branches of industry, as well as the numerous types of instruments manufactured by the company, and their specifications.

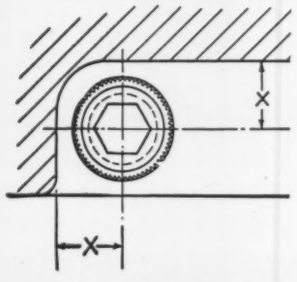
INSULATION—B. F. Goodrich Co., Akron, O., in its catalog section No. 7900 announces its vibro-insulators for application on mechanical equipment to absorb shock and vibration and to reduce noise. Characteristics and specifications of this part, as well as types and sizes available, mounting instructions and technical information are given.

LIGHTS—The new unifocal light, U-58, designed especially for installations on machines and tables which are subject to excessive vibration, is described in a folder recently issued by Fostoria Pressed Steel Corp., Fostoria, O. Another booklet on high intensity lighting which illustrates various types of lamps for different purposes has also been prepared by this company.

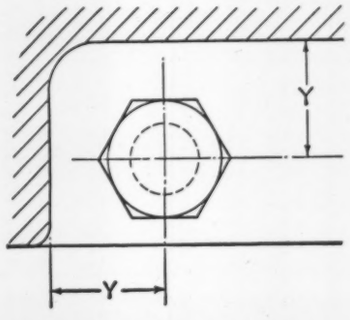
LUBRICATION AND LUBRICATING EQUIPMENT—Feeders designed for operation in a circuit with lubrication flowing alternately in either direction are described in bulletin No. 36-SF, published by Trabon Engineering Corp., 1814 East Fortieth street, Cleveland. The company has also issued a pamphlet on the SH manually operated lubricant pump, characteristics and drawings of which are given.

MOTORS—Up-to-date methods for protecting the field coils of Reliance direct current motors and generators from damp, dirt, corrosive fumes, etc., and from deterioration under severe operating conditions are discussed in an illustrated folder, "Making Bobbin-Type Field Coils," which is being distributed by Reliance Electric & Engineering Co., 1088 Ivanhoe road, Cleveland.

PUMPS—Three bulletins, Nos. 726-A, 727, and 728, have been prepared by Weinman Pump Mfg. Co., 290 Spruce street, Columbus, O. The first bulletin describes and illustrates Unipumps for general service, with capacities



See how the Knurled "Unbrako" snuggles right into the corner.



Notice the great open spaces necessary for the hex-head and wrench.

FOR COMPACT DESIGNS—

The difference between "X" and "Y" in the diagrams demonstrates the decided saving in Clearance, Material, Weight and Cost made possible by using the Knurled "Unbrako" Socket Head Cap Screw.

Obviously, these savings will, in many cases, help to make difficult designs easier and much more compact. Certainly, the "Unbrako" is well worth investigation.

The Knurled "Unbrako" is the *only* Socket Cap Screw with a Knurled head; furthermore, the only one that can be locked, and that will save time in assembling.

Be sure to get our complete and interesting "Unbrako" Bulletin No. 485.

UNBRAKO

STANDARD PRESSED STEEL CO.

BRANCHES BOSTON DETROIT INDIANAPOLIS

JENKINTOWN, PENNA.

Box 102

BRANCHES CHICAGO ST. LOUIS SAN FRANCISCO

ranging from 10 to 700 gallons per minute. Specifications and selection tables for types GB and KB centrifugal pumps for belt or motor drive are discussed in the second bulletin; while bulletin No. 728 gives detailed information on the sump pump.

RUBBER—"A Rubber Plantation in New Jersey," a story of synthetic rubber, has been issued by Thiokol Corp., Yardville, N. J. A great deal of interesting information regarding the discovery, processing, characteristics, applications and advantages of Thiokol, the first commercial synthetic rubber produced, is presented. Qualities of other synthetic rubbers are also discussed. The book portrays the part played by the Thiokol Corp. in the improvement and development of synthetic rubbers—hence the title.

SHAFTS—Complete details as to specifications, types, horsepower, and application of needle bearing flexible drive shafts are presented in bulletin No. 5 of H. S. Watson Co., P. O. Box 385, Toledo, O. The shaft overcomes all types of misalignment as well as small changes in spacing.

TUBING—In the new publication recently announced by Summerill Tubing Co., Bridgeport, Pa., a great deal of new information with regard to alloy steel tubing especially developed for the aircraft industry is given. It also contains column strength curves plotted to cover 75,000 min. yield and 85,000 min. yield, as well as data on properties of steel tubing assembled in a more convenient form for quick reference. In addition to rounds, information for streamlines and special round cornered squares used by the aircraft industry is included. Copies of the bulletin will be sent to executive engineers free of charge only when applied for on company stationery.

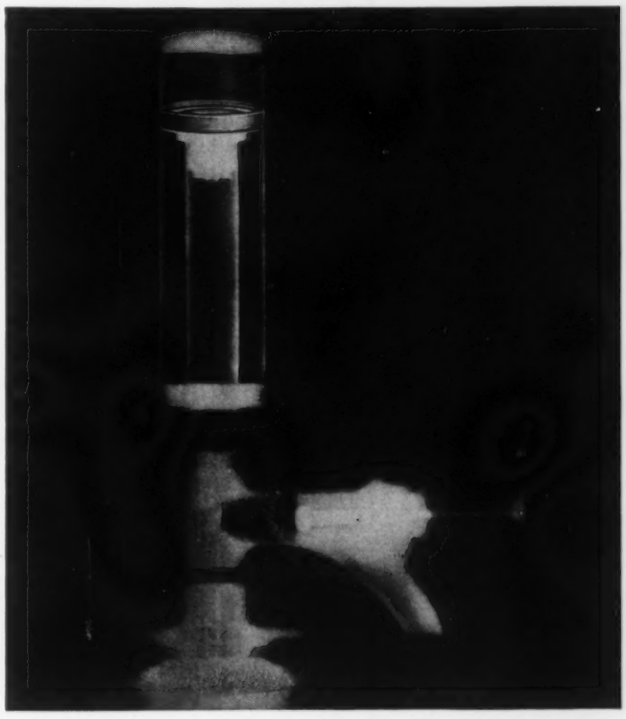
Research Publications

The Air Resistance of Passenger Trains, by F. C. Johansen, M. Sc., (Eng.), Engineering research officer, London, Midland and Scottish railway. Mr. Johansen has made a comprehensive study of air resistance, including the effects of oblique winds, by use of a wind tunnel on reduced-scale models of railway passenger rolling stock. The principal investigation pertains to the aerodynamic forces acting on a locomotive and six passenger coaches in which a separate analysis of the forces acting on each vehicle were measured.

The results show that for fast trains of conventional design, air resistance may absorb large amounts of power of which 75 per cent or more can be saved by streamlining. In fact, the experiments prove that valuable reductions of power at high speeds can be achieved by modifications involving no radical departures from conventional forms of locomotives and coaches. Published by Institution of Mechanical Engineers, London.

X-RAYS POINT TO THE PACKINGS

where our X-ray thinking can cut your designing worries



However simple or complex your machine—if it includes a packing, its lasting, efficient operation depends on a correctly designed closure made of the material exactly suited to the particular job it has to do.

Always ready to help you when your designs reach the packing point*, Graton & Knight engineers have a wealth of packing experience, and a wide variety of special leathers developed in the Home of Research for different packing jobs.

This Packing Problem Stumped the Designer

Plans for a machine that would be years ahead of its competitors were completed. Everything was ready for capturing the market—except that the designer hadn't investigated to see whether the proper packing was available. It wasn't. Even to Graton & Knight, this problem (a packing of very unusual shape) at first seemed almost hopeless. But we were able to design the right packing, and the manufacturer was able to step out ahead of competition.

P. S. It often saves plenty of money if you call in Graton & Knight packing engineers while your design is in the early stages.

Write or wire your Packing Point* problem to Graton & Knight

**The point in any design where the choice of the right packing comes up.*

4229

HOME OF RESEARCH

GRATON & KNIGHT COMPANY

357 FRANKLIN STREET
WORCESTER, MASS.

"Creating Success at the Packing Point"

Business and Sales Briefs . . . . . .

ANNOUNCEMENT is made that A. J. Feltault has recently been appointed general sales and advertising manager of Cuno Engineering Corp., Meriden, Conn., manufacturers of filters for application in machinery.

* * *

W. F. Holtzman has been made manager, Rawplug Washington Co., subsidiary of Rawplug Co. Inc., New York, with headquarters at 50 Florida avenue, Northeast, Washington.

* * *

A. T. Hunt, who formerly had been general sales manager, Eastern Rolling Mill Co., Baltimore, is now identified with the sheet sales division, Bethlehem Steel Co., Bethlehem, Pa.

* * *

Andrew Johnson has been appointed manager of the New York office of National Steel Corp., succeeding Harry Weber, resigned. Mr. Johnson was manager of tin plate sales of the company.

* * *

Appointment of J. A. Krugler as general sales manager of Taylor-Wharton Iron & Steel Co., High Bridge, N. J., has been announced. He succeeds J. C. Taylor, resigned. For the past 12 years Mr. Krugler served the organization as sales engineer. Previous to his association with Taylor-Wharton, he was engaged in railroad and mining work.

* * *

Cecil G. Roush, formerly in the sales division of Westinghouse Electric & Mfg. Co., Kansas City, becomes manager of that office, assuming duties handled by C. W. Hamilton who has been transferred to another activity of the Westinghouse company.

* * *

William E. Umstattd has been elected president of the Timken Steel & Tube Co., wholly-owned subsidiary of the Timken Roller Bearing Co., in addition to continuing his present capacity as president of the parent company. Mr. Umstattd replaces Frederick G. Griffiths, who resigned as president and director of Timken Steel & Tube Co. and director of Timken Roller Bearing Co.

* * *

H. Boker & Co., New York city, have acquired all rights to Kinite alloy die steel, including patents, goodwill, tradename and stock. This alloy will be available both in bars and castings. Sales matters will be handled from the New York office, and Kinite castings, formerly made at Fairmont, W. Va., will be made in Detroit.

* * *

E. I. du Pont de Nemours & Co., Wilmington, Del., has adopted "neoprene" as a generic term for chloroprene polymers formerly sold by the company under the trade-

THE FIRST PRESS TO START IN THE MORNING
The correct oil film to each individual bearing... automatically
American Type Founders
17 x 22 "Kelly" Printing Press
BIJUR
AUTOMATICALLY Correct LUBRICATION
Machines equipped with BIJUR AUTOMATIC LUBRICATING SYSTEMS waste no time! Start your machine . . . automatically the proper oil film is metered to each bearing . . . whatever its type, location, speed, load. No forgotten bearings . . . no excessive feed to spoil work or waste oil. BIJUR . . . the modern aid to maintained accuracy . . . longer machine life . . . quality output . . . uninterrupted production . . . safety . . . reduced costs!
BIJUR LUBRICATING CORPORATION
LONG ISLAND CITY NEW YORK
741

mark "DuPrene." This new engineering material is used in the manufacture of oil and gasoline hose, printing rollers, belting, packing, molded parts for the automotive and refrigeration industries and many other products where rubber-like properties combined with an exceptional stability are important considerations.

* * *

Ajax Flexible Coupling Co., Westfield, N. Y., has announced the appointment of George C. Ewing as New England representative with sales office at 10 High street, Boston, Mass.

* * *

Stearns Magnetic Mfg. Co., Milwaukee, has appointed S. O. Otrich Co., 119 New Montgomery street, San Francisco, as sales representatives for their line of clutches, brakes and other magnetic equipment.

* * *

Headquarters of the western sales division of Boston Gear Works Inc., North Quincy, Mass., according to a recent announcement, will be Cleveland. Storeroom space of the Cleveland branch has been doubled. L. W. Fitch is the branch manager.

* * *

Alexander E. Walker has resigned as general manager of sales for Republic Steel Corp., to become executive vice president of Pittsburgh Steel Co., of which Henry A. Roemer is president. Mr. Walker has been with Republic Steel Corp. and its predecessor, Republic Iron & Steel Co., for 21 years. In 1936 he was elected as president of Truscon Steel Co., a subsidiary of the Republic organization; is a director in Steel & Tubes, another subsidiary, and of various other lesser subsidiaries of Republic.

* * *

Opening of a new branch office located at 804 Judd building, 75 Pearl street, Hartford, Conn., has been announced by Leeds & Northrup Co., 4921 Stenton avenue, Philadelphia.

* * *

B. E. Sivyer Jr. has been appointed branch manager of the San Francisco office of Chain Belt Co., Milwaukee, Wis. His headquarters will be at 366 Brannan street, San Francisco. The company also announces that its Portland, Ore., office has been moved to 112-118 Southwest First avenue.

* * *

Five new vice presidents have been elected by the board of directors of General Electric Co. They are: M. O. Troy of Schenectady, manager of the central station department; L. T. Blaisdell of Dallas, southwestern district manager; E. H. Ginn of Atlanta, southeastern district manager; A. L. Jones of Denver, Rocky Mountain district manager; T. S. Knight of Boston, New England district manager.

The company now has nine commercial vice presidents in charge of sales districts. In addition to those elected last month there are H. H. Barnes Jr., New York City, New York district; W. O. Batchelder, Chicago, central district; J. A. Cranston, San Francisco, Pacific and northwestern districts; W. J. Hanley, Cleveland, east central district; and C. K. West, Philadelphia, Atlantic district.

You Save 4 Ways with INSUROK GEARS and BEARINGS

INSUROK—the superior plastic developed by Richardson—offers genuine production economies in the paper mill. Used for gears and bearings, INSUROK (1) cuts power transmission costs; (2) maintains uninterrupted schedules; (3) gives longer life, freedom from frequent costly replacements; (4) improves working conditions by eliminating noise, screech and howl in driving equipment.

In addition to gears and bearings, INSUROK lends itself to numerous other uses in the paper mill . . . all given in detail in an interesting brochure which is yours for the asking, along with a copy of the INSUROK Handbook.

RICHARDSON PAPER MILL SERVICE

Without cost or obligation the Richardson Research, Design and Engineering departments will be glad to cooperate with you in the application of INSUROK to your production processes.

The RICHARDSON COMPANY

Melrose Park, (Chicago) Ill. Founded 1858 Lockland, (Cincinnati) Ohio
New Brunswick, N. J. Indianapolis, Ind.
FORMERLY, The RICHARDSON PAPER COMPANY
Detroit Office: 4-252 G. M. Building, Phone Madison 9386
New York Office: 75 West Street, Phone Whitehall 4-4487